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AN ECONOMETRIC MODEL

OF

PRINCE EDWARD ISLAND

BY
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FOREWORD

During the last several years, much attention has focussed on the problem of disparities in income and employment opportunities, and standards of living among the regions of Canada. In an attempt to alleviate such regional disparities, many studies have been undertaken, several government agencies have been set up and many programs have been implemented.

In the spring of 1969, the governments of Canada and the Province of Prince Edward Island signed an agreement to put into effect a Comprehensive Development Plan for the Province. The "Plan" is a 15 year, $728 million cost-shared program "designed to substantially increase the capability of people, businesses, and other institutions of the Province to guide and take full advantage of opportunities provided by the rapidly changing social and economic environment of Canada and the world at large."[1]

This econometric model is part of a series of studies which were undertaken to provide those responsible for formulating Plan policy, with an in-depth analysis of the PEI economy, and to offer insight into the expected effects of alternative program mixes. The idea of building the model was conceived early in 1968. Work on the project commenced in August 1969 under the direction of Mr. Keith Wornell, now Assistant Secretary to the Treasury Board of Prince

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1 Department of Regional Economic Expansion, Canada, Development Plan for Prince Edward Island, p. 27.

Edward Island. The project was funded under the Comprehensive Development Plan.

Michael Lane
Economic Advisor
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PREFACE AND ACKNOWLEDGMENTS

The model presented below attempts analysis rather than prediction. A strictly predictive model captures movements in several strategic variables with (as few as possible) easily projected exogenous or "outside" variables; whereas, a strictly analytical model attempts to specify more meaningful (and often more complicated) relationships with exogenous variables which generally are not easily projected into the future. There are other and more subtle differences, but for our purposes it is only necessary to understand these polar extensions.

Suffice it to say, these two types of models are not mutually exclusive and equations of both types and fulfilling both purposes appear in most econometric models, as they do in the following model.

The model's equations were "fit" on the provincial government's IBM 1130 computer using a stepwise regression program. The simulation and sensitivity analysis program was developed by the Institute of Public Affairs, Halifax and was run on the Dalhousie University IBM 360/50 computer.

The construction of this econometric model could not have been accomplished without the assistance and encouragement of many individuals, organizations, and both federal and provincial government departments. So many have contributed that it would be impossible to name all. I would like to single out Michael Lane for his assistance and support and Keith Wornell for his direction, continued stimula-

tion and helpful comments. My thanks also to Len Bradley; Ann Cunningham; David Darlington, chief economist, Department of Labour, Industry and Commerce; Data Processing Center (George MacNeil); Department of Development Library (Don Scott); Dominion Bureau of Statistics (Ellis Drover, Claude Hudon); Glen Hughes, Department of Education; Institute of Public Affairs, Halifax, (John Palmer); Lynda Mosher, typist; Dr. J. Lovering, agricultural economist, Canada Department of Agriculture, Research Station, Charlottetown; Bruce McKee, Newstart, PEI; Baxter Ramsay, graphic artist; and Gordon deWolf, economist.

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CHAPTER I

*

INTRODUCTION

In the formal presentation of the econometric model which follows, an analytical discussion of some of the more important economic relationships of the PEI economy is presented. An attempt has been made to understand these relationships in light of past and present economic activities.

WHAT IS AN ECONOMETRIC MODEL?

An econometric model consists of a system of "fitted" equations. These equations, each of which "explains" one chosen variable, are grouped into sectors (such as Agriculture, Manufacturing, etc.). In turn, these sectors are grouped into a larger entity - the model. It is through this building-block process, from equation to sector to total system, that an econometric model is constructed.

Seen as a whole (and depending upon its adequacy of representation) an econometric model is a working facsimile of an economy and, as such, allows for intensive study of that system. The interpretation and interrelation of its components (equations and sectors) yield insights into the structures, sensitivities and movements of an economy. The economy, in the form of a model, may then be subjected to shocks, manipulations and journeys into the future. Further, journeys from previous time periods to the present, along

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* This chapter presents a brief overview of the methodological issues raised by and during the construction of an econometric model. The subject matter is presented in non-rigorous fashion and an attempt has been made to make the explanations as clear as possible. A more general treatment of the important problems is presented in Appendix A.

paths differing from those actually followed, are possible and often desirable from an analytical viewpoint.

The usefulness of such a tool for government purposes is evident so long as the limitations of this (and for that matter, any) analytical technique are understood.

THE REGRESSION AND CORRELATION PROCEDURE

The "fitted" equations that form the core of the model are determined by the Least Squares (LS or OLS for Ordinary Least Squares) regression method. This method defines a procedure which sets up an *association* between at least one independent variable and one dependent variable. It does this by minimizing the sum of the squares of the distances (hence the term least squares) between the "fitted" OLS line and the observation points. In Fig. I a regression line (PQ) of the form

$$Y = a + bX$$

is "fitted" to the observed data points i, j and k, where Y is the dependent variable; X, the independent variable; a, the Y-intercept (OA); and b, the slope of the regression line.[1] The OLS procedure produces an equation for the line PQ such that the quantity $[(i - l)^2 + (j - m)^2 + (n - k)^2]$ is a minimum, i.e., is less than that for any other possible line.

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[1] a and b are known as the regression coefficients. The coefficient + (or -) a in the equation Y = + (or -) a + bX is interpreted as the value of the dependent variable when the value of the independent variable is zero. The coefficient + (or -) b in the equation Y = a + (or -) bX is interpreted as the proportion of change (in units of Y) that is *caused* by a one unit change in X.

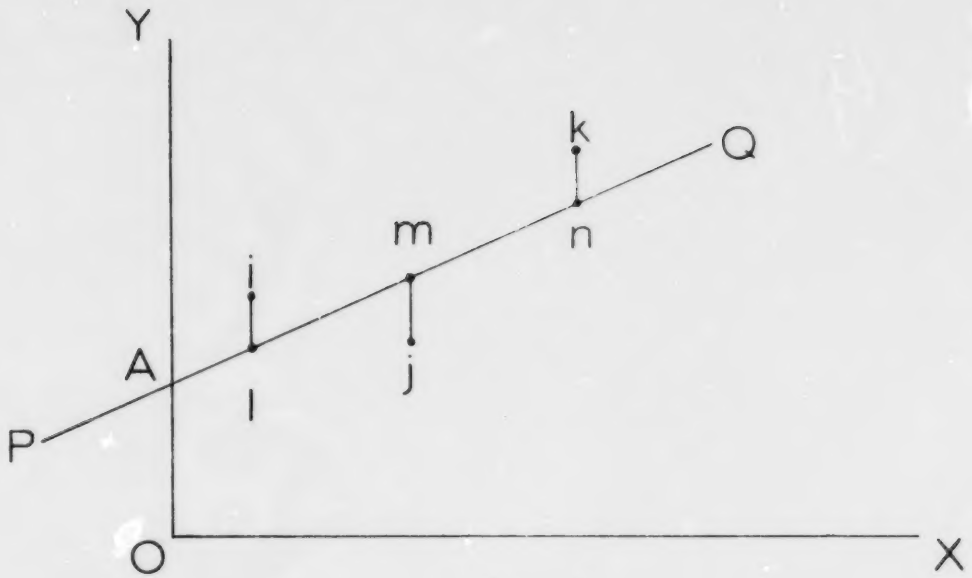

Fig I

Just as the CLS procedure produces a "fit" between any two or more sets of data, the correlation procedure "measures" the closeness of this fit. The correlation coefficient r is a measure of the "strength" of a relationship, i.e., the closeness with which the observed points are aligned with the regression line.[2]

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[2] The simple correlation coefficient is r. It measures the association between sets of data of the form, $Y = a + bX$. The multiple correlation coefficient is R. It measures the association in sets of data of the form, $Y = a + b_1X_1 + b_2X_2 + \ldots + b_nX_n$, where $n > 1$.

In the model we generally deal with r^2 and R^2. These statistics are the simple and multiple coefficients of determination and their values (translated directly) tell us what percentage of changes of the dependent variable are "explained" by changes in the independent variable(s). (In the rest of this chapter R and R^2 are used interchangeably with r and r^2, for the purpose of presentation.)

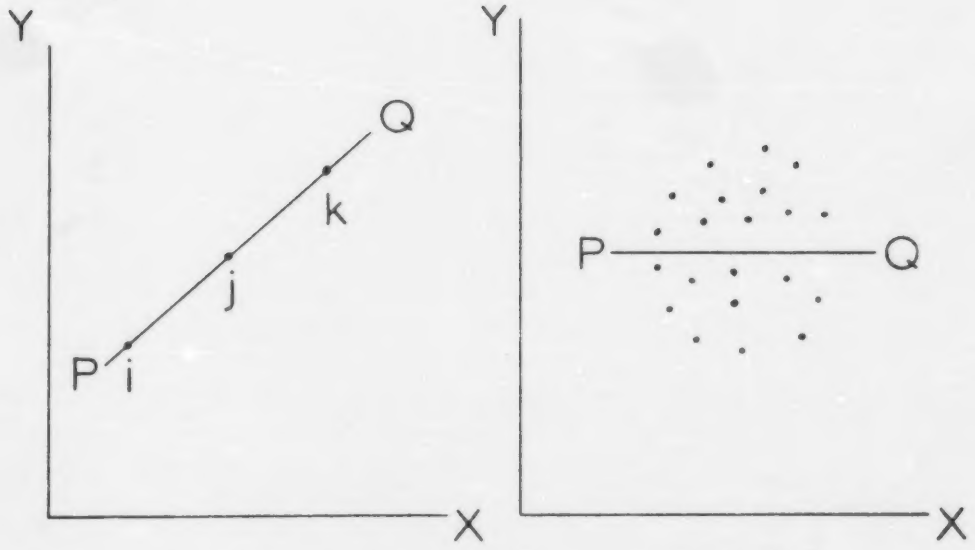

Fig II A Fig II B

The value of r can vary between -1 and +1 and therefore the value of r^2 can vary between 0 and 1. A value of $r^2 = 1$ (Fig. IIA) signifies that the relationship is perfect, i.e, for every value of the independent variable there corresponds one precisely estimated value of the dependent variable; a value of $r^2 = 0$ (Fig. IIB) signifies that there is no relationship, i.e., for all values of the independent variable there corresponds only one estimate of the dependent variable. These extreme values ($r^2 = 0$ and $r^2 = 1$) seldom result from the estimation and correlation procedure. This is due, in part, to difficulties of specification and measurement, but largely to the minor inconsistencies of economic activity. Equations, as formulae, can only approximate "real" situations. They produce exact specifications; whereas, human behavior is, at best, expressed in patterns of activity. As a practical problem, this limitation leads to the appearance of the *disturbance* term, which is discussed in the next section.

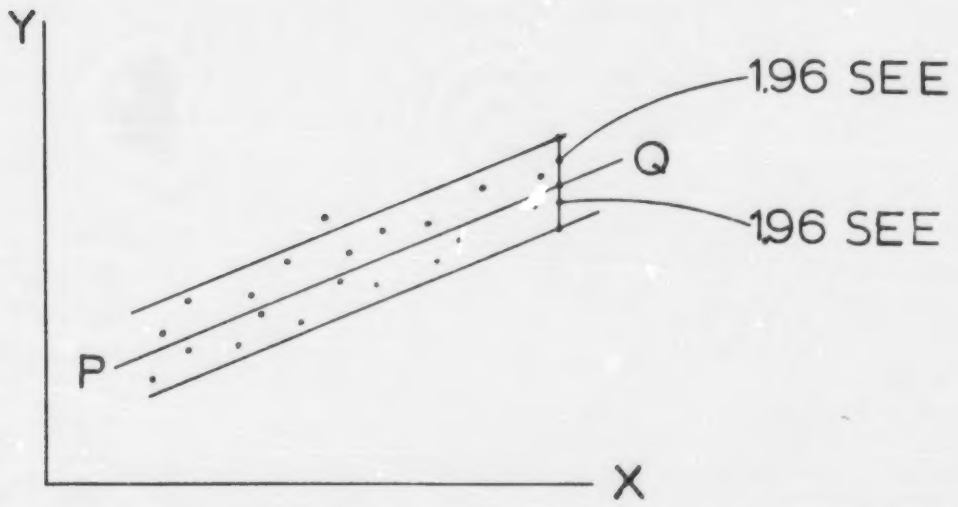

Fig III

The *standard error of estimate* (SEE) is a standardized measure of dispersion of given points about the regression line. The smaller the SEE, the closer are the points to the regression line (when SEE = 0, then all the points are on the regression line, i.e. $r^2 = 1$). In terms of statistical inference, by drawing two lines parallel to the regression line (PQ), the first 1.96 SEE above and the second 1.96 SEE below the regression line (Fig. III), we necessarily include at least 95% of all points entering into the derivation of the regression line.

TYPES OF VARIABLES

In the model we estimate equations of the form:[3]

$$Y = a_1 + b_1X_1 + b_2X_2 + \ldots + b_iX_i + e$$

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3 Or $\hat{Y} = a_1 + b_1X_1 + b_2X_2 + \ldots + b_iX_i$, where $\hat{Y}$ is the estimated value of Y in any given year. $\hat{Y}$ equals the value of a plus b_1 times the value of X_1 in that year plus b_2 times the value of X_2 in that year plus ... plus b_i times the value of X_i in that year.

where Y is the variable[4] *under explanation* (analagous to the algebraic expression *dependent*); X_1, X_2, ..., X_i, the *explanatory* variables (analagous to the algebraic expression *independent*); e, the disturbance term; and, a_1, b_1, b_2, ..., b_i, the regression coefficients. Those variables known as *dependent* or *under explanation* are also called *endogenous* and those known as *independent* or *explanatory* are also called *predetermined* or *exogenous*, *lagged exogenous* and *lagged endogenous*.[5]

Variables may be either random or fixed. A random variable is a statistical variable that has a probability associated with all of its possible values. For example, if we let V, the value of a random variable, equal the reading from the throw of a "fair" die, we have PROBABILITY (V=1) = 1/6, PROBABILITY (V=2) = 1/6, and so on. A fixed variable[6] is one which has been given a value for the period or purpose in question. If k is the value that our fixed variable takes on then PROBABILITY (V=k) = 1. An example of a fixed variable is the level of total government expenditures in the time period t.

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4 See below for a more general discussion of the types of variables.

5 Lagged variables are those variables whose values have been determined in the immediately preceding or earlier time periods. They are denoted by subscripts t-k where k is equal to or greater than 1. In the model, we use only lags of the form (t-1), e.g. $VA_{M(t-1)}$.

6 Although the term *fixed variable* is self-contradictory it serves to demonstrate the differences between random and fixed variables

Theoretically the *disturbance* e should be a random variable since it results from the 'inherent irreproducibility of social and biological phenomena'. However, we have neither the knowledge nor the capability to specify exactly all the variables that should appear in all the equations, and therefore, this *disturbance* is actually an arithmetic *residual* which is calculated by subtracting Y_t (current actual) from $\hat{Y}_t$ (current estimated). The discrepancy between the actual and the calculated disturbance terms is due to measurement and specification error. Except in extreme circumstances we cannot know whether the e's do or ever can closely approximate the real disturbances.[7]

An *endogenous* variable is a random variable whose value in each period is dependent upon the values of the predetermined variables. In econometric models variables specified as endogenous are usually those about which something is to be determined or learned.

As noted, the variables previously referred to as *explanatory* variables are called *predetermined* variables. In any equation these variables act as if they were determined in advance of the current time period.[8]

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7 For each equation in the model we have calculated the Durbin-Watson statistic (D-W). This statistic tests for the degree of autocorrelation in our residuals; that is, to what extent (if at all) current residuals are dependent on past residuals. For the situation in which

$$e_t = be_{t-1} + u_t \text{ (where } u_t \text{ is the disturbance term)}$$

has a significant value for r, the OLS estimates become fouled and are no longer dependable.
This problem is discussed more fully in Appendix A in the section on Estimation.

8 The specification of an endogenous variable as exogenous will create bias in the regression estimates.

Exogenous variables act as if they were determined "outside"[9] the system. They are defined by the requirement that in each time period, their value must be statistically independent of the disturbance terms in all time periods. Exogenous variables may be random or fixed.

Lagged exogenous variables may be treated similarly to exogenous variables since they form a subset of the set of exogenous variables.

Lagged endogenous variables often cause difficulties for estimation purposes.[10] The difficulties manifest themselves in the *a posteriori* properties of the disturbance terms. Lagged endogenous variables may fail to be predetermined[11] when

(a) all past disturbances are not independent of present disturbances,

(b) current disturbances are not independent of their own lagged values (Autocorrelation).

PRINCIPAL COMPONENTS

In econometrics it is frequently necessary to explain a whole complex of events in terms of some much simpler relation. For

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9 That is, they must be determined in an equation where none of the model's endogenous variables appear.

10 See Appendix A. Multicollinearity and autocorrelation are examined in the section on Estimation.

11 They thus cause problems for a recursive system since each equation must contain only one endogenous variable, see Appendix A.

example, time is often used as a proxy for changing tastes and attitudes, for changing forms and methods of production, and, for the natural growth of bureaucracy.

Another method often used is the construction of weighted averages. If two variables (X_1 and X_2) have some effect on a third variable (X_3) and if the first variable has twice the effect of the second variable, then we may use $2X_1 + X_2$ as the value for X_3. The *principal components* method is one such "weighting" procedure having the desirable statistical property that its weights produce uncorrelated components and thus differential effects are more easily recognized.

Our model makes use of *principal components* as a means of constructing indices in the welfare sector.[12] This is accomplished by the combination of several variables, those contributing to a general definition of the index, into a more manageable data series which can then be meaningfully "fed" into the regression process.

TYPES OF EQUATIONS

In building a model we assume the existence of a *structure*. This *structure* must be relatively constant for the time period of study and, given the proper exogenous variables must determine *uniquely* the statistical distribution of all endogenous variables.[13] In other words an econometric model sets out a structure which attempts

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12 For a comprehensive discussion of *principal components* see; Cooley and Lohnes, Multivariate Procedures for the Behavioral Sciences; and, for an interesting discussion of welfare indices, see; U.S. Dept. of Health, Education and Welfare, Toward a Social Report.

13 See Christ, Econometric Models and Methods, p. 153.

to approximate actual economic relationships.

Economic *structures* are depicted by at least four types of equations:

(1) Behavioral: these equations describe the behavior of some group(s) in the economy. For example consumers adjust purchases to their anticipated income and farmers adjust production to their expectations about movements in product prices.

(2) Technical: these equations, typically production functions, depict the "limitations imposed on output by existing technical and engineering knowledge".[14]

(3) Institutional: these equations specify legal regulations such as marginal tax rates, or income tax deductions.

(4) Definitional (also referred to as accounting, balance or identity equations): these equations are set up as definitions, such as total personal income equals wage income plus farm income plus ... or such as Gross National Product = Gross National Expenditure.

Equations of types (1) and (2) are usually estimated and equations of types (3) and (4) are usually determined *a priori*.[15]

THE RECURSIVE MODEL[16]

The recursive model is a system of equations which explicitly

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14 ibid., p. 67.

15 This is the general rule, there are exceptions.

16 For a more detailed description of the recursive model, see Appendix A.

points out the order, effect and direction of the economy's relationships. It is so defined and arranged that its equations may be solved sequentially in a chain-like fashion.

We may solve the system:

$$Y_1 = a_1 + b_1X_1 + e_1 \qquad (1)$$

$$Y_2 = a_2 + b_2Y_1 + c_2X_2 + e_2 \qquad (2)$$

where Y_1 and Y_2 are endogenous variables; X_1 and X_2 are predetermined variables; e_1 and e_2 are disturbance terms; and, a_1, a_2, b_1, b_2 and c_2 are regression coefficients, by

(a) directly calculating Y_1

(b) substituting Y_1 into equation (2) and solving for Y_2.

When suitable for the depiction of an economy, the recursive format has the added advantages of simplicity of calculation, clarity of expression, and ease of communication.

SENSITIVITY AND SIMULATION ANALYSIS

The potential of an econometric model seems to be a direct function of the use made of it. It is through the use of the model as a whole and as a system that its most interesting aspects may be emphasized.

Sensitivity, or "shock" analysis consists of subjecting the economy to major exogenous shocks. This may be done (a) by doubling each exogenous variable, one at a time, and observing the effects on the economy as a whole and (b) by changing some of the behavioral or institutional constants as estimated and observing the effects on the economy as a whole.

Simulation analysis may be used to represent the economy as a mechanism whereby various combinations of large scale policies are attempted and their effects on the economy may be recorded and studied.

Using these analyses we can follow the path of the economy as it would have progressed subject to our manipulations.[17] Thus a wide range of experiments is possible and decisions may be made concerning the system's sensitivities, its stability and its dynamic characteristics.

> "Some advantages of simulation stem from the fact that the solution of the model is numerical. Experimentation with a computer model is a good pedagogic device. It is possible to observe the dynamic interaction of different variables by examining the time series generated by various simulation runs of a model. The studying of these time series can be very fruitful for gaining insights into the workings of economic systems and in suggesting new hypotheses."[18]

THE TARGETS-INSTRUMENTS APPROACH

The model developed for the PEI economy makes use of an adapted

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17 "One of the most intriguing simulation applications [of an econometric model] is the examination of economic history. By varying the movement of exogenous variables and shifting autonomous and other parameters, it is possible to determine the course of the economy under altered conditions. This yields insights into its basic stability and indicates what might have taken place under more [or less] favorable circumstances." Fromm and Taubman, Policy Simulations with an Econometric Model, p. 27.

18 Suttor and Crom (1964), p. 1343.

form of Jan Tinbergen's instruments-targets methodology.[19] Since the model is essentially for the use of the PEI government, this methodology enables us to see more clearly the operation of the direct and indirect instruments over which the government exercises some degree of control.

Directed government policy-making or socio-economic planning implies some form of comprehensive policy-implementation. In other words, a framework, or objective structure, is set out in which planners work towards achieving specified goals. These goals are then given numerical value and become targets.

The procedure is not simple. In practice one finds that there are many "levels" of difficulty in defining objectives and thus in achieving goals and targets.[20]

Corresponding to the various levels of objectives yielding definable quantitative targets, there exist various "levels" of difficulty in attempting to fulfill them. This leads to the problem of choice and implementation of certain policies to achieve the stated targets. These policies and the means whereby an attempt is made to fulfill goals are called instruments. Any planner has several of these instruments, some more effective and some less effective, at his disposal. Once again these instruments are on different levels and have differing degrees of

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19 J. Tinbergen, Economic Policy: Principles & Design and On the Theory of Economic Policy.

20 Two targets that are on different "levels" are: (1) to increase the Gross National Product by 50% before 1980; and, (2) to make Canada a better place in which to live.

effectiveness.[21] It is the duty of the planners to choose that instrument-mix which promises to be the most effective.

Once goals and objectives have been established it seems only natural to consider the processes by which these goals are to be achieved.

One of the principal hypotheses developed during the model-building exercise is that the instruments of the provincial government are less powerful and more sluggish than those of the federal government, and therefore regional policymakers are more constrained than their national counterparts. It must be understood that our regional system is overly sensitive to outside, or exogenous, shocks because (a) of our small size, and (b) "efficiency" practices are not well-defined and established and consequently are not institutionalized. This is especially true in a small-scale setting (such as PEI) where, for example, prices for most home-consumed exportable goods are determined elsewhere. With a "perfectly" elastic[22] demand for this region's products, and a "perfectly" inelastic[23] supply of most of its goods, it is unreasonable to expect that we can "control"; rather, we must manipulate. The insignificance of this region's economy in relation to, and its dependence on, the national economy dictates that we work at lower, or micro, levels; and that the model

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21 Optimally, the number of effective instruments should at least equal the number of targets.

22 Strong negative demand response for increases in PEI product prices.

23 No price response to changing PEI demand patterns.

reflect the influence of the national economy on local economic activity.

As previously stated, the model has been conceptualized using an adapted Tinbergen-type methodology. It has not gone far beyond "classical" lines in defining instruments because of the limitations on this government's possible and actual scope of activities. There are several reasons for this: (1) No clearly visible and specifically quantifiable objective (welfare) function has been defined; (2) the PEI economy is relatively open and the PEI government does not possess absolute sovereignty within its borders; (3) it is much more difficult to apply the Tinbergen system on more micro levels; (4) at this writing there exists no system of regional accounts;[24] and (5) data, especially in the tourist and other service industries, is too often unavailable.

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24 A comprehensive system of regional accounts is presently nearing completion.

CHAPTER II

THE MODEL: SECTORAL PRESENTATION

The model contains nine sectors. Most of the variables in each sector have distinguishing labels (either as subscripts, variable names, or identifying letters):

Agriculture		- A
Fisheries:	Inshore	- FIS
	Offshore	- FOS
Construction		- C
Manufacturing		- M
Output		- OP
Population		- POP
Government		- PG and G
Income		- Y
Welfare		- J

Each variable (with several obvious exceptions) is represented by two labels. The first is a general abbreviation of the variable's name[1] and the second, a subscript, denotes the sector in which the variable appears. The additional subscript (t-1) means *last year's value*, i.e., the value of that variable in the last year. An uncapitalized letter with a bar over it signifies an average value (eg. $\bar{y}_A$ is net income per farm and $\bar{y}_P$ is personal income per person where Y_A and Y_P are, respectively, total net farm income and total personal income). The symbol $\equiv$ means *is defined to equal* or *is identical to*.

Since most economic relationships are "real" relationships, compari-

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1 Where possible, the general abbreviation is made to closely resemble the spelling or pronunciation of the variable's name. For example, OP = output, VA = value added, I = investment, K = capital stock, and (having used the I for investment) Y = income. J as the first letter in any variable name indicates that the variable is an index, eg. JEDCN = index of education.

sons cannot be made without some standard frame of reference.[2] Therefore, all monetary variables are deflated by appropriate price indexes to yield "real" variables. Specific price indexes exist only for agriculture and the fisheries.[3] Monetary variables in the other sectors have been deflated by a general price index, which is the average of the Halifax and St. John (N.B.) consumer price index.[4]

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2 There are other, more technical, arguments. See Christ, (1956).

3 The agriculture product and cost price indexes (both Laspeyre price indexes) were obtained directly from the Dominion Bureau of Statistics (DBS). The fisheries price indexes were calculated for the model by using the historical catch and value data of fish landings by species (available from DBS) and constructing the Laspeyre price indexes.

4 Recent studies of the Charlottetown area have developed price indexes that compare favourably with the above usage.

AGRICULTURE

Prince Edward Island's agricultural sector is dominated by small farm business units. Land use is often inefficient and modern farming practices are not widespread.

Approximately 25% (a decline from 50% in 1950) of PEI's residents live on farms. Their farming operations account for seven percent (20% in 1950) of total PEI personal income. Between 1950 and 1969 the number of census farms[5] decreased by one-half, while total improved acreage declined by one-eighth, resulting in an 80% increase in average farm size. In the same period, the monetary value of total farm capital[6] has doubled, although in real terms (deflated by the price index of farm costs) it has increased by only 50%.

Similar to producers in other primary sectors, PEI's farmers are price takers. Often making little or no net income for their efforts (return to labour), they are very sensitive to price fluctuations. On a comparative 1961=100 basis[7], prices for PEI agricultural products have compared favourably with Canadian farm

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5 Defined as, "agricultural holdings of one acre or more with sales of agricultural products during the past twelve months of $50 or more". DBS 96-631, 1966 Census of Agriculture, PEI, p. 2.

6 Defined as land and buildings plus implements and machinery plus livestock and poultry.

7 For each series, the 1961 price level is set equal to 100 and the preceding and succeeding years' price levels are calculated as proportions of this value.

1961=100

Fig IV A farm product price index

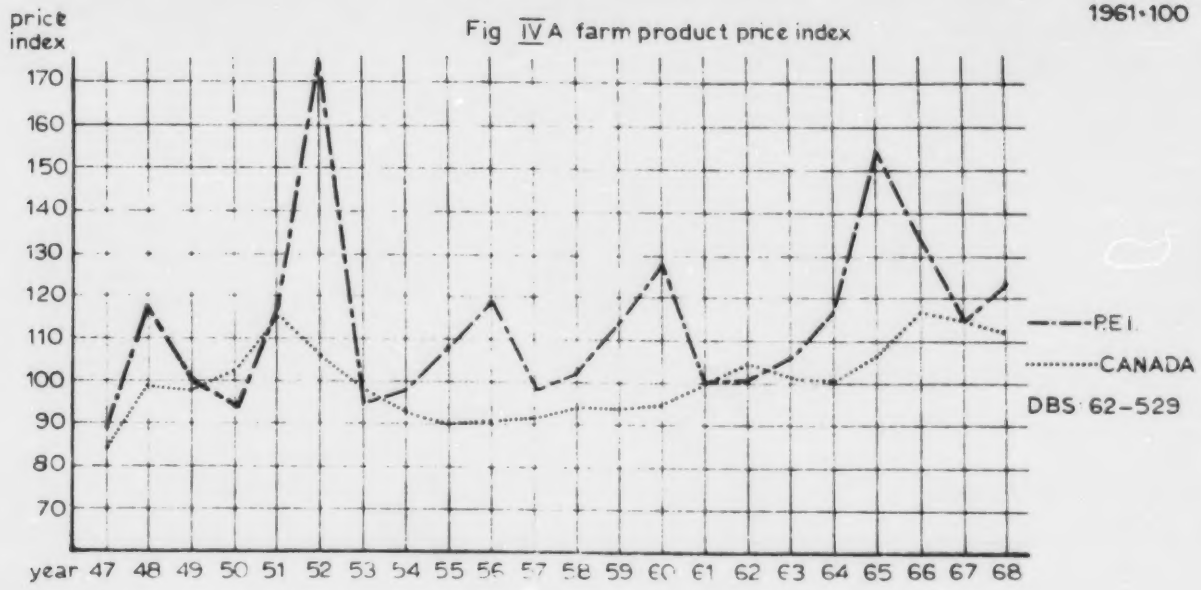


Fig IV B farm cost index

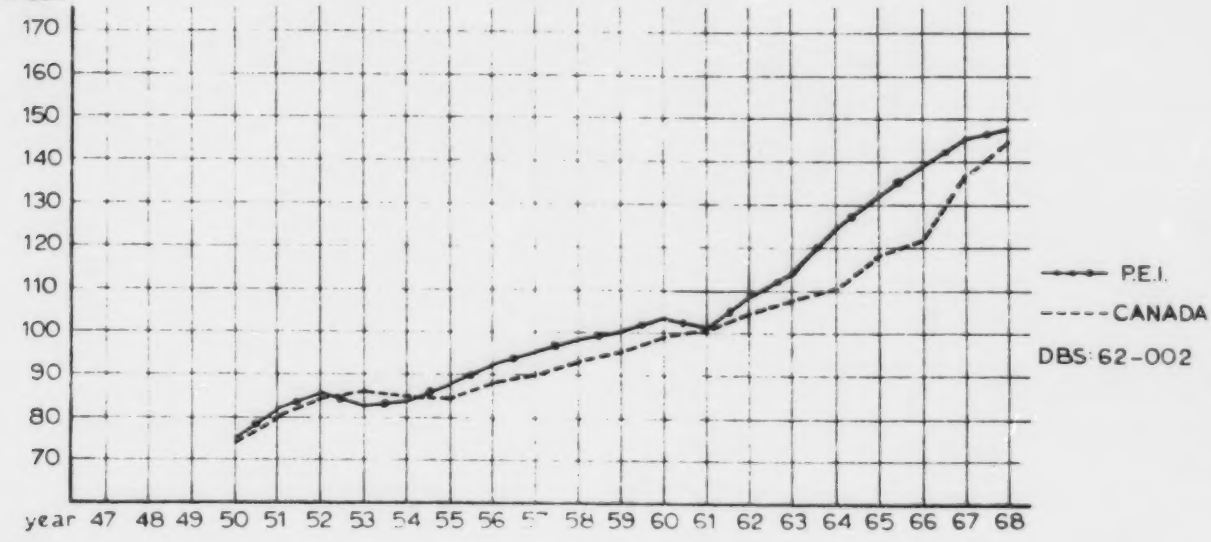
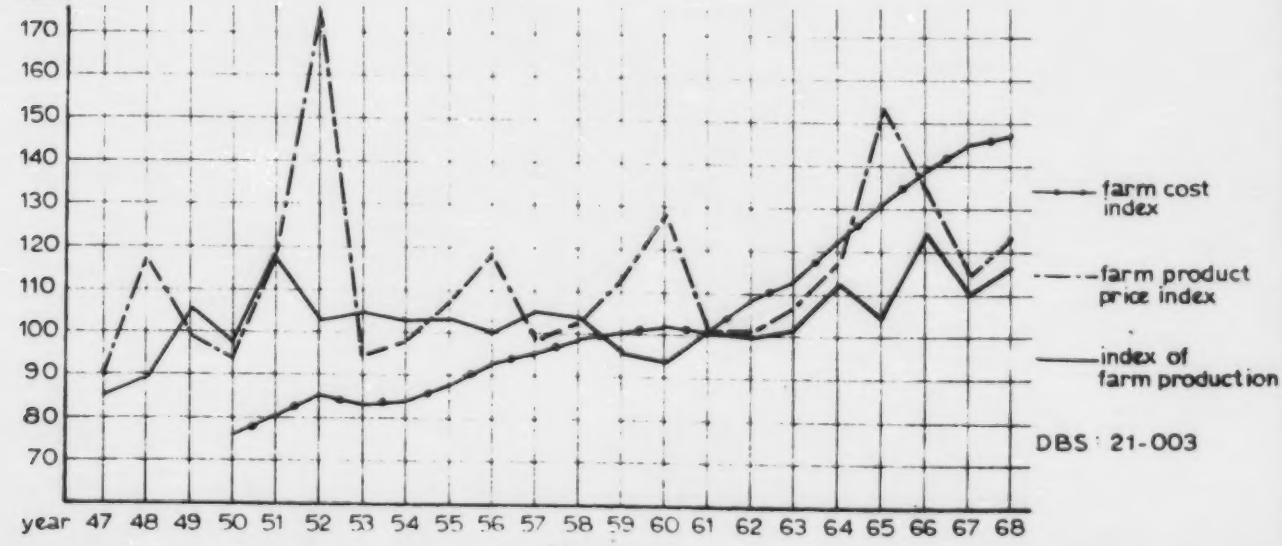


Fig V P.E.I. farm indicators



product prices[8] (Fig. IVA). Similarly, costs to PEI farmers[9] compare favourably with Canadian farm costs (Fig. IVB). With several exceptions, notably in the last few years, PEI product prices have generally been at higher respective levels than the cost prices (Fig. V). Further, as cash receipts from farm products has increased by 175% in the last two decades, the physical volume of agricultural output has remained nearly constant, thus implying that increasing prices account largely for the increased monetary value of output.

The first equation in the agricultural sector relates average farm size (in acres per farm) to the farm cost index (1961=100), the farm product price index lagged one year (1961=100) and total net agricultural income lagged one year.

A1: $F_A = 55.9397 + 0.6578\ P_{AC} + 0.1755\ P_{A(t-1)} - 0.0011\ Y_{A(t-1)}$

$(R^2 = .9462)$

This equation states that average farm size this year varies positively with both (a) farm cost prices and (b) farm product prices in the last year. There is a negative relation between total farm income lagged one year and average farm size this year, which in fact has occurred in real terms. Average farm size equals total farm acreage divided by the total number of farms (TFA/#F), and since total farm acreage has remained almost constant in the last twenty years, much of the change in average

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8 Potato prices, however have not consistently varied according to the trends in general agricultural prices. The coefficient of determination between P_P and P_A is .1323 (1947-1968).

9 The index used is not specifically for PEI farmers, it includes all eastern Canadian farmers.

farm size is accounted for by changes in the total number of farms (since it is the low income farmers that are more likely to leave farming). Those that remain in business[10] apparently react to decreases in income (and increases in cost versus product prices) by increasing their capital positions and thereby attempting to increase output and consequently income. Yet, in real terms there is no visibly significant relationship between value added and output ($r^2 = .1417$), and not much of a relationship between output and income ($r^2 = .4159$). (This suggests an interesting phenomenon which appears also in equations A2 and A4.)

A2: $K_A = 126326.47 + 10.6892\ CDT_A - 398.058\ SQZ_A$

$(R^2 = .8619)$

Capital stock is a positive function of credit usage (Farm Credit Corporation and Farm Establishment Board loans) and a negative function of the cost squeeze (farm product price index divided by farm cost price index, or P_A/P_{AC}). Intuitively, it would seem that capital stock would not increase in periods when costs are at relatively high levels compared to product prices; but, as previously stated PEI farmers affected by this "squeeze" react by increasing the size of the farm business unit.

A3: $OP_A = 11966.117 + 0.1366\ K_A + 118.1064\ \%C_A$

$(R^2 = .8562)$

Total agricultural output (cash receipts from farm products) is a positive function of both capital stock and the percentage of all

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10 See discussion of equation A4, especially that relating to footenote 15.

farms that are commercial farms.

A4: $\bar{y}_A = -776.698 + 0.1368\ VA_A + 10.8355\ F_A - 0.0219\ K_A + 5.954\ P_A$

$(R^2 = .9629)$

Net agricultural income per farm is related positively to value added in agriculture[11], average farm size and the farm product price index; and negatively to capital stock.

Value added "fit" into several preliminary versions of this equation and was significant in all cases, yet all attempts at relating output to income were unsuccessful. The negative coefficient for capital stock suggests that although capital directly influences output, capitalization is not the panacea for rising costs and declining incomes.[12] Although capital stock directly (and positively) influences output, since output has no direct relation with value added, which directly (and positively) influences net income per farm[13], it is not surprising that this negative coefficient occurred and was statistically significant in all preliminary "fits"

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11 "Operating expenses (excluding taxes on all farm land, net farm rent, depreciation, purchased services, wages to paid labour and interest on mortgages and other debt) are deducted from gross farm production (less house rent) to give the census value added." DBS 61-202, Survey of Production, 1967, p. 9.

12 "Increases in business size without a preceding or coincident increase in management skills will likely result in increased difficulties because operators would have to service new and high cost loans (F.C.C. rates at the time of writing being 8.75 percent). It may be hypothesized that these factors explain, in part at least, the past and present low levels of usage of commercial credit. On the same basis it is reasonable to suppose that credit use will not increase until increased skill levels result in greater net farm incomes." in Coffin, E. and Buote, L. (November 1969)

13 And also total net agricultural income.

of both net income per farm and total net agricultural income equations. In general PEI farms are over-capitalized - capital/output ratios are often too high as a result of overly large machinery inventories which are caused by both misallocation of resources and lumpiness of the input[14]. This is not to suggest that all PEI farms are over-capitalized - the regression procedure "fits" equations in terms of averages or generalities and not in terms of distributions.[15]

A5: $Y_A \equiv \bar{y}_A \times \#F$

This equation defines total net agricultural income equals net agricultural income per farm times the number of farms.

The major policy implication in this sector of the model is that, inasmuch as government may control capital formation, it may have some significant effect[16] on this province's level of real net income per farm. The present land use patterns[17] of this sector and its sensitivities to price variations and farm size changes

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14 Dr. J. Lovering, an Agricultural Economist at the Canada Department of Agriculture, Research Station in Charlottetown, concurs with this interpretation.

15 Nevertheless, an average or a mean is a statistic derived from a distribution; and as such, gives information about that distribution.

16 By changing the distribution and not necessarily the quantity of its credit.

17 Bradley, Idle Land or Farm Expansion? A Study of How Social Problems Affect Farm Consolidation in O'Leary, Prince Edward Island, (Unpublished).

indicate that improved managerial efficiency and concentrated marketing efforts are of primary importance since the bottleneck is not caused by a lack of available capital.

THE FISHERIES

In Prince Edward Island there is a sharp distinction between the inshore and offshore fisheries according to location, size and range of boats, type of organization and species of fish landed. Consequently, the model contains two fisheries subsectors.

THE INSHORE FISHERY

Inshore fishing takes place around the Island's perimeter. Fishing out of small harbours, the boats used (usually 25-45 feet in length) have a range of about twenty miles. These boats normally make daily fishing trips, the frequency of which depends upon weather and sea conditions.

In terms of value, lobster is by far the most important species landed - its value ranging between two-thirds and three-quarters of the total value of inshore landings. The price per pound has quadrupled in the last twenty years, and demand for lobsters continues to show healthy increases. However, as the value of the lobster catch has increased dramatically, landings per man has remained almost constant in the last thirty years. The limitation on this fishery is the supply of the lobster resource[18]. As a

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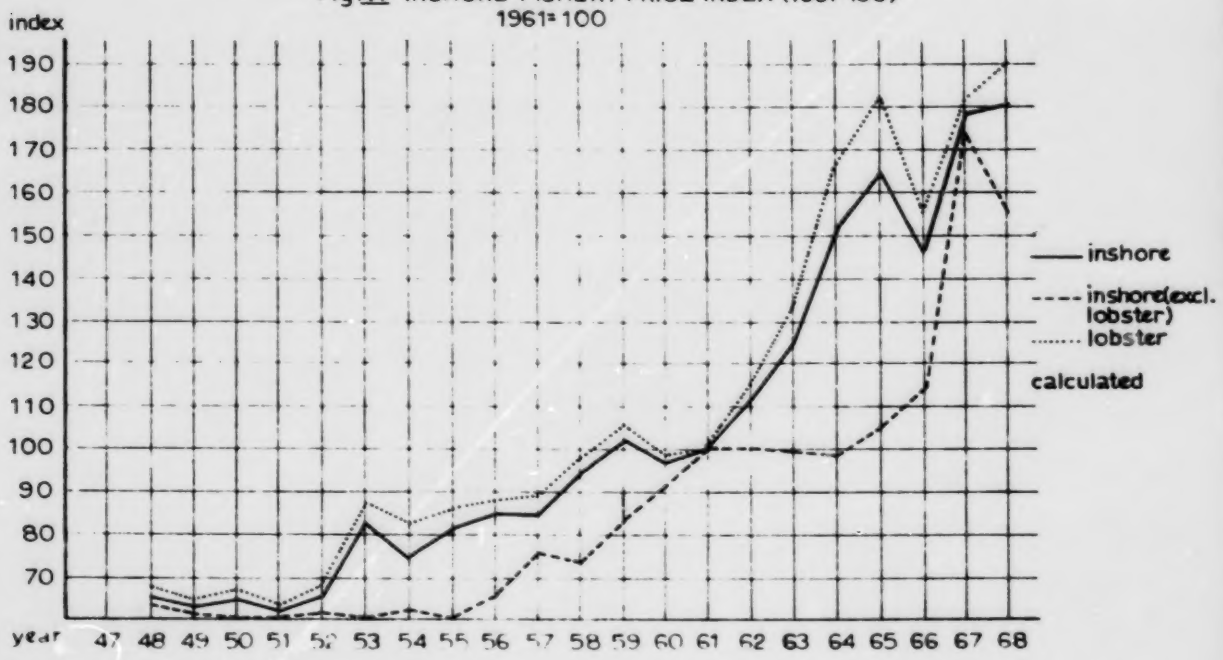
18 Present rates of yearly exploitation vary between 45% and 80% of the entire stock. Rutherford, Wilder, Frick, An Economic Appraisal of the Canadian Lobster Fishery, p.18.

result there is only one annual two-month season in each of the two lobster fishing districts on the Island.

Conditions permitting (and this is at most seven months of the year), inshore fishermen may fish other species for five more months. A wide variety of fish are caught; but, due to inconsistency of fish supply, poor price performance (see Fig. VI), and high average overhead costs, the inshore fishery has not proven profitable since prices have not risen to compensate for the increased costs and increased capital demands[19]. Several inshore fishermen now take tourists on half-day excursions, but this is not widespread since tourists tend to congregate in certain small well-defined

Fig VI INSHORE FISHERY PRICE INDEX (1961=100)



19 Increased capital has not been translated into increased productivity. Both in (constant) dollars and weight, landings per man has remained almost constant over the last twenty-five years.

areas. Recently, optimism has been generated concerning the possibility of expanding the collection of Irish Moss. This plant grows on the ocean bottom in shallow waters, has many uses, and is now being harvested quite extensively in some areas. (Moss landings are now worth well over $1 million annually and in terms of value landed are second only to lobster landings.)

There is much concern about the status of the inshore fishery on Prince Edward Island. Following, are remarks from two studies:

> "This (sector) by common consent, is characterized by excess manpower, low productivity, low income and high unemployment, and is considered perhaps the most dramatic example of the region's need to transfer redundant manpower resources to more productive employments."[20]

> "It is clear that the inshore fishery throughout the Atlantic provinces is an instrument of poverty. Far too many men, boats and equipment are being applied to a basically limited resource."[21]

It is difficult to incorporate an inshore fishery sector into an econometric model because some of the variables which are considered to be important (and which would therefore be specified as endogenous) are not economically determined. For instance, it has proven impossible to "fit" an equation which explains total landings

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20 Walinsky, Evaluation of Economic Research Relating to the Atlantic Region, p. 16

21 Atlantic Development Board (ADB), Fisheries in the Atlantic Provinces, p. 33-34.

or landings per man, because the supply of fish is a biological, and not an economic, fact. No extra amount of capital equipment on an inshore boat will improve total catch if the fish are not present. To this fishery the supply of fish is limited by the range of the boats. Total catch, therefore, depends to a large extent on environmental factors and to a lesser extent on work effort, entrepreneurship and capital stock.

FIS1: $K_{FIS} = -13.1177 + 0.6391\ K_{FIS(t-1)} + 44.4679\ P_{FIS(t-1)} - 0.6533\ Y_{UE} - 22.3379\ P_{FL}$

$(R^2 = .9328)$

Capital stock in the inshore fishery[22] depends upon capital stock in the inshore fishery lagged one year, the inshore fishery price index lagged one year, total unemployment insurance payments and the lobster price index. The casual observation that fishermen react to the (dis)incentive of lobster prices and unemployment insurance payments is here confirmed. Capital stock is sensitive to the incentive of good inshore fish prices and disincentive of good lobster prices.[23] Additionally, the incidence of higher unemployment insurance payments, has a similar effect on fishing effort in this sector, since there is a trade-off between other-than-lobster fishing effort and the possibilities of unemployment

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22 Defined to include boats, engines, fishing gear and shore equipment.

23 This is confirmed by several discussions with fishermen.

insurance income. Further,

> "unemployment insurance, as administered, constitutes a serious disincentive to the exodus of surplus labor from the fishery, and hence to increased productivity."[24]

FIS2: $E_{FIS} = 3205.6816 - 0.23\ K_{FIS(t-1)} - 23.5759\ P_{FL} + 30.5421\ P_{FIS}$

$(R^2 = .8650)$

Employment in the inshore fishery is a negative function of capital stock, since men and capital are substitutes, a positive function of inshore prices, and a negative function of lobster prices, for reasons stated above.

THE OFFSHORE FISHERY

PEI's offshore fishery is composed of about twenty 55-128 foot boats, plus two or three processing plants. Total landings are approximately $1 million per year of which at least 90% in both value and weight is groundfish. Both landed value per man and prices (Fig. VII) have increased slowly.

> "A study carried out by the Department of Fisheries has concluded that the return on investment made in the Atlantic primary fishery has been very low when compared with the return on investment in other industries. (Proskie, Costs and Earnings of Selected Fishing Enterprises, Atlantic Provinces 1964. Economic Services, Department of Fisheries, Ottawa.) This lower rate of return, the report states, has failed to attract sufficient investment capital from private sources. Thus,

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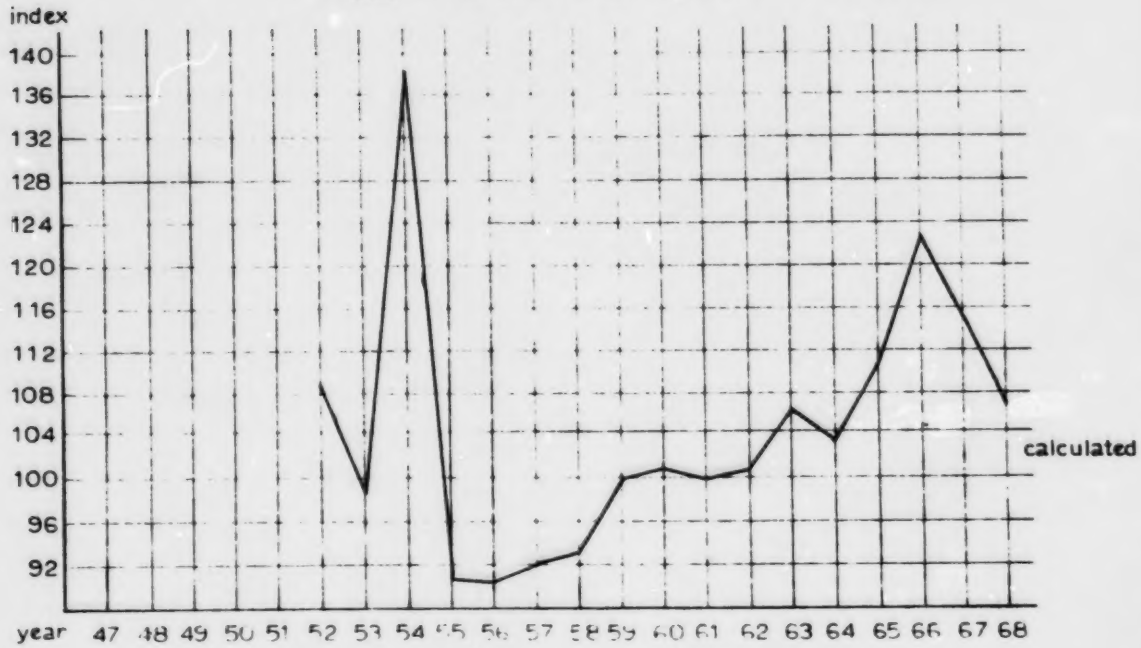
24 Walinsky, op. cit., p. 16.

expansion of the fishery has been centered around aid from governments in the form of grants to vessel construction and low interest loans."[25]

Fig VII OFFSHORE FISHERY PRICE INDEX (1961=100)



In the last five years the value of loans per year has averaged $1 million per year. Unfortunately, catch has not increased proportionately and profitability[26] has most often decreased with any increase in capital stock.

FOS1: $K_{FOS} = 59.8168 + 0.8101\ CDT_{FOS} + 51.6463\ B_{FOS} - 32.2706\ \pi_{FOS(t-1)} - 64.6292\ C_{FOS(t-1)}$

$(R^2 = .9820)$

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25 Atlantic Provinces Economic Council (APEC), Atlantic Provinces Fishery, 1968, p. 19.

26 Defined as: net earnings of boat share as a percentage of average net investment.

Capital stock in the offshore fishery depends positively on credit used[27] and number of boats fishing; and negatively on profitability in the previous year and boats built in the previous year. The interpretation of all the coefficients, except for the minus sign before $\pi_{FOS(t-1)}$ is straightforward. As profitability has decreased from year to year capital stock has correspondingly increased - a phenomenon similar to that encountered in the agricultural sector.[28]

FOS2: $I_{FOS} \equiv K_{FOS} - K_{FOS(t-1)}$

Net investment this year equals capital stock this year minus capital stock last year.

FOS3: $OP_{FOS} = 45.5082 + 0.3430\ K_{FOS} + 15.523\ C_{FOS}$

$(R^2 = .9589)$

Output in the offshore fishery (value of fish landings) depends on capital stock and the number of boats built.[29]

FOS4: $E_{FOS} = -17.9909 + 0.0541\ OP_{FOS(t-1)} + 0.0124\ I_{FOS} + 0.2695\ P_{FOS(t-1)}$

$(R^2 = .9864)$

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27 Defined as: Boat Construction Assistance plus Fisherman's Loan Board mortgages.

28 Where, unsuccessfully, output is increased in attempts to increase scale and therefore income.

29 The difficulty that arises in completing an inshore fishery sector does not occur in the offshore fishery. Since offshore fishing boats have much larger ranges, the fish supply to them can be seen as infinite and therefore catch is an economic variable determined by capital, etc.

Employment in the offshore fishery is a positive function of output lagged one year, net investment, the offshore fishery price index lagged one year, and the number of boats fishing.

FOS5: $\pi_{FOS} = 2.918 - 0.0096\ K_{FOS} + 0.004\ CDT_{FOS} + 0.2707\ B_{FOS} + 0.35\ \pi_{FOS(t-1)}$

$(R^2 = .9518)$

Profitability in the offshore fishery is positively related to credit used, to number of boats fishing and to profitability last year; and, negatively related tc capital stock.

Once again we have a sector in which credit policies create capital which negatively influences profits. Although the process here is depicted as being more complex, the simple finding is that a general expansion of output accomplished by a general expansion of capital stock has not led to a proportional expansion in income or profits.

POPULATION

Fig VIII A P.E.I. POPULATION, 1871-1966

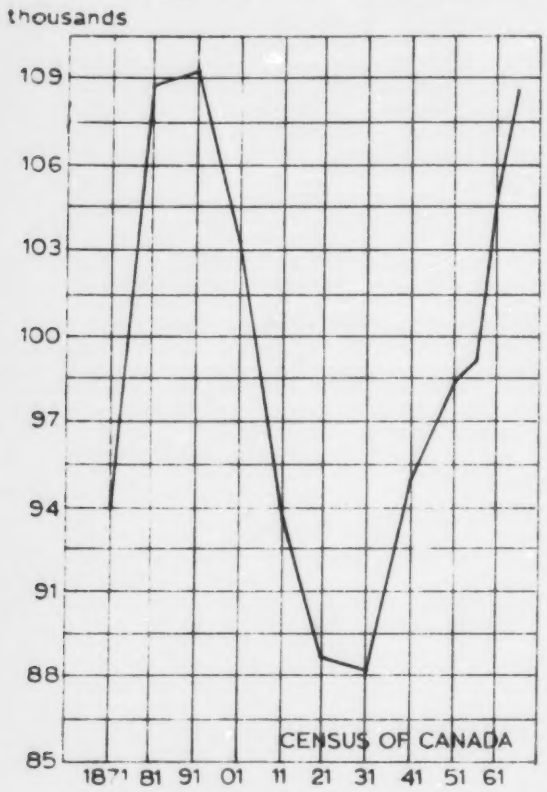
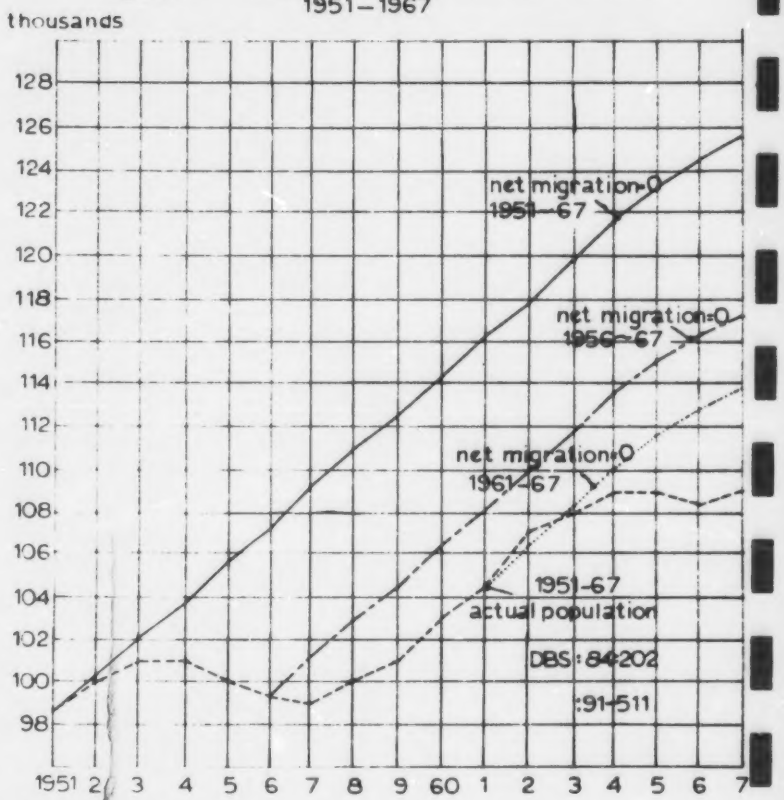


Fig VIII B ACTUAL AND EXPECTED POPULATION 1951–1967



A glance at the whole model shows the importance of population as a determinant of several aggregate variables. Since population has itself been so variable, it has often acted as an exogenous force on demand in the various sectors. Although, once a net accumulator of people (Fig. VIIIA) Prince Edward Island has long been a place from which people migrate. The redundancy of farm labor as productivity has increased and the pull of central Canada with its cities and promises of higher incomes have continually drawn many of the Island's more mobile residents.

Fig. VIIIB gives the actual and expected population assuming that

net migration was zero from 1951 to 1968, from 1956 to 1968, and from 1961 to 1968. If net migration had been zero from 1951 to 1968, the population in 1968 would have been approximately 126,500; and if net migration had been zero from 1961 to 1968, the population in 1968 would have been approximately 114,800; rather than the actual figure of 109,000.

TABLE 1: PERCENTAGE STRUCTURE COMPOSITION, PEI-CANADA (1951-1966)

AGE GROUP PEI

	0-14	15-19	20-24	25-34	35-39	40-64	65+	TOTAL
1951	33.43%	8.43	6.61	12.91	6.40	22.36	9.86	100%
1956	34.84	8.26	6.14	11.08	5.94	23.36	10.37	100
1961	36.04	8.51	6.02	10.61	5.45	22.94	10.42	100
1966	34.65	10.23	6.26	10.05	4.98	22.86	10.69	100

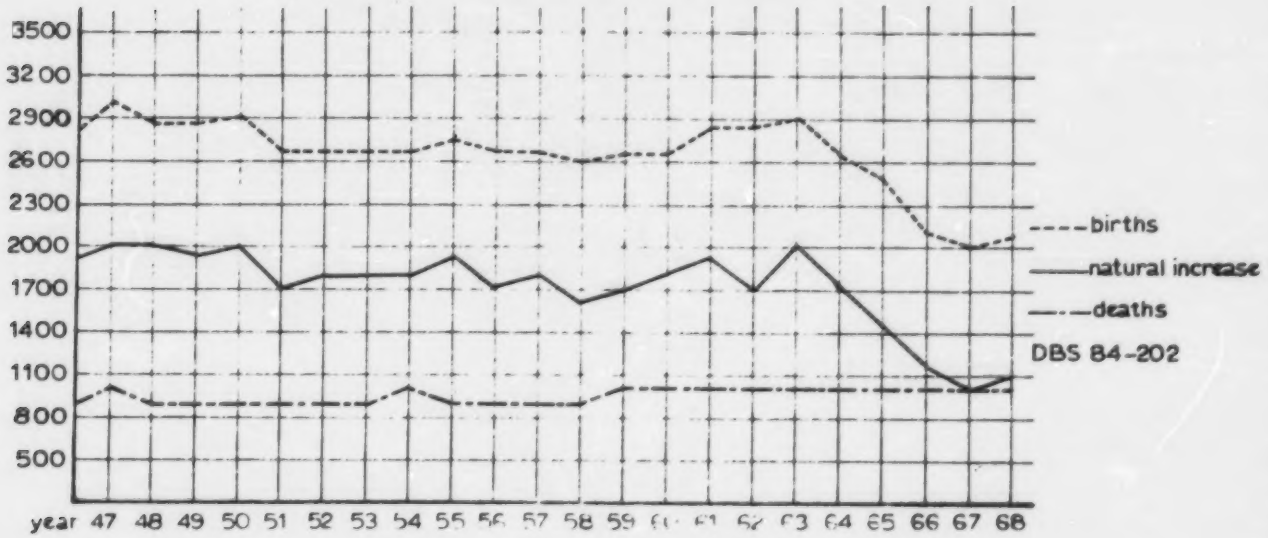
AGE GROUP CANADA

	0-14	15-19	20-24	25.34	35-39	40-64	65+	TOTAL
1951	30.36%	7.55	7.77	15.51	7.13	23.93	7.75	100%
1956	32.50	7.23	7.02	10.01	6.93	23.58	7.73	100
1961	33.95	7.85	6.49	13.60	6.97	23.51	7.63	100
1966	32.93	9.18	7.30	12.41	6.43	24.06	7.69	100

TABLE 1 presents a comparison of the changes in the age structure of the population of PEI and Canada between 1951 and 1966. Compared to Canada, PEI consistently has a higher percentage of its population in the 0-14, 15-19, and over 65 age groups, and a consistently

lower percentage of its population in the 20-24, 25-34, 35-39, and 40-64 age groups.[30] Thus PEI has a smaller percentage of its population in the productive age groups and a larger percentage in the non-productive age groups.[31]

Fig IX · Births, Deaths & Natural Increase, 1946-1968



Not only has out-migration prevented the population from growing at a faster rate, but the rate of natural population increase (births minus deaths) has also decreased due to a significant decline in the annual number of births (Fig. IX).

Originally, it was hoped that a complex population sector would be included in the model. Unfortunately, PEI population data is

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30 The effect of this factor is seen in the Gross Provincial Product equation, p. 48.

31 A recent study has shown that 42.3% of all migrants (net) are in the 20-24 age group and 54.5% of all migrants (net) are between 20-29 years old. See APEC, The Atlantic Economy: Summary, (Second Annual Review), 1968.

poor. Due to rounding and small sample estimates[32], errors may be large enough to invalidate many valid hypotheses. For instance, a figure of 98,000 for PEI population means that the PEI population estimate was somewhere between 97,501 and 98,499. This problem is not too difficult to overcome for the population figures; but, for migration figures, one must be more careful since net migration equals expected population (in this period) minus actual population (in this period)[33].

P1: $^{e}POP \equiv POP_{(t-1)} + NI\ (POP_{(t-1)})$

Expected population this year equals actual population last year plus the rate of natural increase times actual population last year.

P4: $POP \equiv {}^{e}POP - MIG$

Actual population this year equals expected population this year minus net migration this year.

The following two equations estimate aggregate labour force parameters. Data errors here are larger than those for population estimates (eg. assuming accuracy of the exact figure an estimate of 35,000 signifies a figure between 34,501 and 35,499 and a range of approximately 3%) and therefore no attempt was made at disaggregation or complexity.

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32 Due to the nature of DBS data collection procedures.

33 See below, equation P3.

P2: $e_L \equiv PPR \times e_{POP}$

Expected labour force this year equals population participation rate[34] times expected population this year. The population participation rate has been declining during the past twenty years; this is attributable to the age structure of the population.

P3: $L \equiv 2.3702 + .9223\ e_L \qquad (r^2 = .9622)$

Actual labor force is a function of expected labor force.

Undoubtedly, more accurate and detailed studies of PEI population characteristics are required. Cross-section, time series, micro and macro studies are necessary to derive more accurate estimates of population, migration and labor force. In addition, studies emphasizing the effects of per capita population characteristics on the various sectors would be most helpful as an aid for discerning whether policy goals should be set on aggregate levels or whether concern should center at the more individual levels, since development policies for these two options may differ widely.

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34 Total labor force divided by total population.

CONSTRUCTION

Presently employing over 2,300 people, construction is probably the fastest growing industry on PEI. In the last twenty years the real value of total output has more than doubled and construction now accounts for more than one-third of PEI's total value added in the commodity producing sectors.

> "Unlike other commodity-producing industries, activity in the construction industry is not autonomous, but depends almost entirely on the demand for building in other sectors of the economy including government."[35]

In the model the components of total construction output (value of work performed) are represented as functions of exogenous (to the construction sector) variables only. Employment and total wage bill are then derived as functions of this demand on the industry.

C1: $OP_{CR} = -83910.047 + 906.0433\ POP - 0.7871\ MIG - 1170.3034\ \bar{t}(Y_p)$

Value of residential construction performed depends on population, migrations and average tax rate.[36] Residential construction depends on population since population increases are often the result of changes in migratory patterns. As expected, net migration appears in the equation with a negative coefficient because the distribution of migrants is skewed towards those age groups that tend to buy houses.[37] Since most residential construction

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35 APEC, The Construction Industry in PEI, p. 1.

36 Equals total personal income tax divided by total personal income.

37 See previous section, POPULATION.

occurs in the Charlottetown and Summerside areas and since most of PEI's income tax is paid out of earnings in these areas[38], there appears a negative coefficient for the average tax rate.

C2: $OP_{CI} = 1861.82 + 1.7133\ PG_{PW}$ $(r^2 = .8069)$

Value of institutional construction work performed is a function of provincial government total expenditures on public works[39]. The provincial government and other institutions (most of which are sponsored by the provincial government) contract approximately one-half of all construction work performed on PEI[40].

C3: $OP_{CT} = OP_{CR} + OP_{CI} + OP_{CC}$

Total value of construction output equals output in residential construction plus output in institutional construction plus output in commercial construction. The latter variable is treated as exogenous due to lack of adequate data.

C4: $VA_{CT} = 4335.4287 + 0.3068\ OP_{CT}$ $(r^2 = .8684)$

Total construction value added[41] is a function of total construction output.

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38 Approximately 40% of income and 50% (or more) of total personal income tax paid comes from the Charlottetown area alone.

39 Defined as: total provincial government expenditures in highways, winter works and other construction projects.

40 See APEC, op. cit., p. 26.

41 Defined as: total value of construction work performed minus cost of materials used.

C5: $E_C = 2074.2871 + 0.1141\ Y_{IR(t-1)} + 0.0735\ OP_{CT} - 0.0169\ GPP$
$(R^2 = .8765)$

Construction employment depends on rental and interest income of persons last year, total construction output, and gross provincial product. The former two are indicators of demand for construction work and the latter's negative coefficient reflects the provincial government's policy (highway construction, etc.) of employment and income stabilization. Through the (often political) medium of construction employment, some degree of fiscal policy is attempted.

C6: $W_C = -3909.4428 + 0.1823\ VA_{CT(t-1)} + 2.6377\ E_C + 0.5671\ Y_{IR}$
$(R^2 = .9400)$

The total construction wage bill depends on value added in construction last year (a proxy for income), employment in construction and rental and interest income of persons.

MANUFACTURING

The manufacturing sector on PEI is largely involved in processing the products of the Island's farmers and fishermen. Gross manufacturing output is approximately $40 million annually and total employment is about 2,300. The average weekly manufacturing wage is one-half the Canadian figure and employment is often seasonal.

In general, plants are too small[42] to benefit from economies of scale. Encountering stiff competition, may have closed down and medium size plants (those employing 15-50 people) now contribute about 30% of total manufacturing output. Larger plants, those employing more than 50 people are producing approximately 50% of total manufacturing output.

At least two-thirds of the manufacturing sector is engaged in food and beverage processing and is therefore subject to the fluctuations of an often volatile market. Attempts at rectifying the problem are even more difficult in PEI considering the small contribution of its manufactures to the Canadian market.

Specifying a manufacturing sector to be included in the PEI model was more difficult than anticipated. There is no time series data on manufacturing incomes or profits or capital stock and no general PEI manufacturing product or cost price index. Investment was specified as exogenous since the investment decision on PEI is seldom an internal (to the firm) economic decision. National

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42 More than one-half employ less than five people.

economic conditions and government policies are often the most important factors determining investment on PEI.

M1: $\bar{w}_M = -10.6525 + 0.4417\ \bar{w}_{M(t-1)} + 30.0423\ DCPI + 0.00007\ GPP$
$(R^2 = .9534)$

Average weekly wages and salaries are dependent on average weekly wages and salaries last year, the change in PEI consumer price index since last year and gross provincial product (GPP). The lagged value of weekly wages and the change in the consumer price index imply a behavioral "ratchet" effect which suggests that once at a level, wages next year will move upward. In this and the following equation GPP, by representing general economic conditions on PEI, ties this sector to the other sectors in the local and the national economies.[43] This is a labor supply equation since the higher (lower) the weekly wage the more (less) people apply for work.

M2: $W_M^T = -539.6552 + 0.0207\ GPP + 0.2519\ VA_{M(t-1)} + 0.2104\ I_{M(t-1)}$
$(R^2 = .9860)$

The total manufacturing wage bill is dependent on GPP, value added in manufacturing last year (a proxy for manufacturing income) and investment in manufacturing last year. This is a labor demand equation, the greater the "designated" wage bill, the more labor will be demanded and *vice versa*.

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43 See equation for GPP (OP1) in section entitled OUTPUT.

M3: $E_M = 2833.8901 + 0.2113\ W_M^T - 13.3712\ \bar{w}_M + 28.4231\ PS1_M - 23.4982\ PS2_M \qquad (R^2 = .9693)$

Manufacturing employment depends on total wage bill, (negatively on) average weekly wages and salaries, plant size indicator 1[44] and (negatively on) plant size indicator 2[45]. As labor demand (W_M^T) increases so will employment, and as wages increase (with a designated wage bill) employment will decrease. Additionally, those larger firms in the sector affect employment positively in terms of size of establishment and negatively in terms of output of these establishments, since the larger firms tend to be more capital intensive.

M4: $OP_M = -7435.8603 + 17.7621\ E_M - 46.2972\ ESTB_M + 440.0719\ JOWN_M \qquad (R^2 = .9477)$

Since there is no time series on capital stock in manufacturing, it was impossible to "fit" a production function in technical form. The alternative chosen was to fit output as a function some indicators of the composition of the sector. The equation explains output[46] as a function of employment, the number of establishments,

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44 Defined as: proportion of manufacturing employment in those firms employing 15 or more people.

45 Defined as: proportion of manufacturing output originating in those firms employing 15 or more people.

46 "Value of shipments of goods of own manufacture", DBS, 31-204.

and the index of ownership[47]. The negative coefficient attached to the number of establishments variable reflects the greater degree of larger-firm manufacturing now undertaken on PEI. The large coefficient of the index of ownership confirms the same hypothesis concerning economies of scale and organization.

M5: $VA_M = -2624.7939 + 0.3671\ OP_M$ $(r^2 = .9493)$

This equation, stating that value added[48] is a function of output, is used, not only as an indicator of value added, but also as a statement that over the last twenty years for each additional dollar of manufacturing output, value added has increased by almost 37¢.

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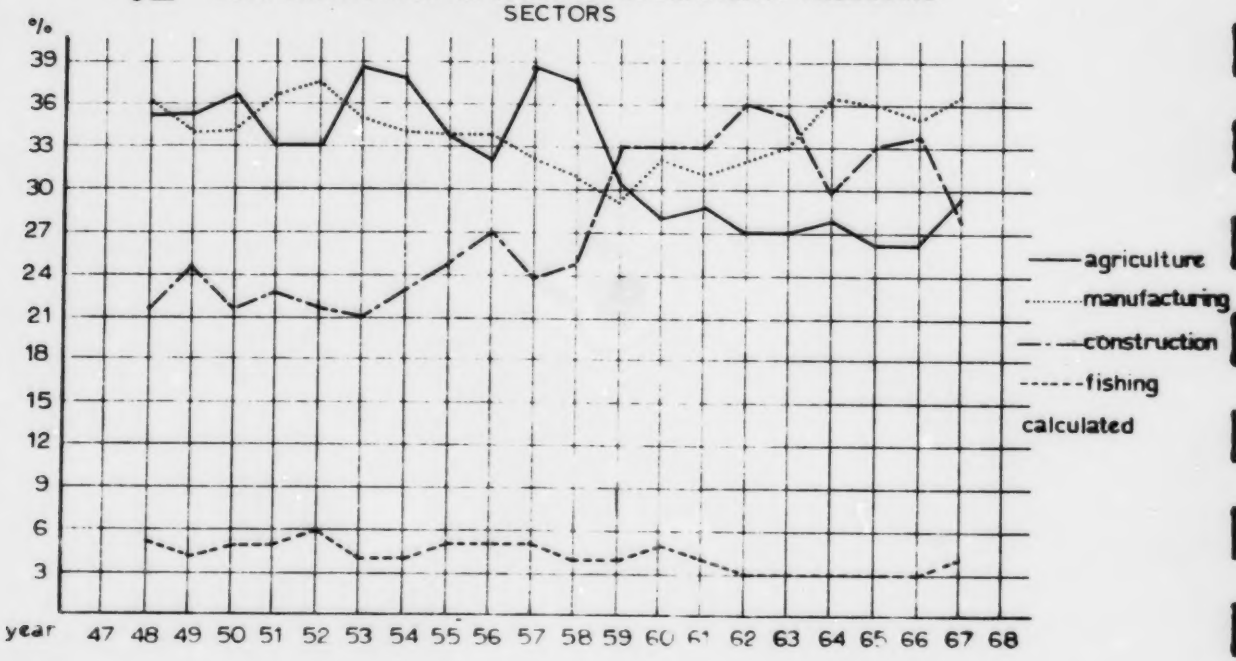
47 Defined as: the proportion of establishments that are incorporated. (It must be noted that this index, and the manner in which it appears in the equation suggest no inherent benefits from the enlargement of the corporate segment in this sector. In this case it is unreasonable to generalize from the PEI experience.)

48 "The census value added is derived by first adjusting the value of shipments for the change in the value of inventory of finished goods and goods-in-process and then subtracting the cost of materials, fuel and electricity used." DBS 61-202, op. cit., p. 11.

OUTPUT

Gross Provincial Product has increased quite substantially (almost fourfold) in the last twenty years. A major proportion of the increase is due to increased expenditures of the federal government on PEI.

Fig X COMPONENTS (%) OF REAL OUTPUT IN COMMODITY PRODUCING SECTORS



In this same time period, total real output of the commodity producing sectors has doubled. Construction has increased its proportion of total commodity output; while the proportion of fish landings and manufacturing output have remained almost constant, and the proportion of agricultural output has declined. (Fig. X)

OP1: $GPP = -74353.1564 + 2155.1377\ PPR + 0.00332\ GNP$

$(R^2 = .9822)$

Gross Provincial Product depends on the population participation rate (PPR) and on Canadian Gross National Product. PPR in PEI has been falling relative to the rest of Canada, a fact which is reflected in the age structure of PEI's population and of its migrants[49]. The dependence of GPP on GNP ties the model's provincial economy to the national economy, a dependence which tends to be quite strong due to the large and increasing expenditures of the federal government in PEI.

OP2: $OP_{CP} = OP_A + OP_{FIS} + OP_{FOS} + OP_{CT} + OP_M$

Output in the commodity producing sectors[50] is defined to equal output in agriculture plus output in the inshore fishery plus output in the offshore fishery plus output in construction plus output in manufacturing.

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49 See discussion of age composition of PEI population and migrants in section on POPULATION.

50 OP_{CP} is not to be confused with the DBS category of output in the goods producing sectors.

GOVERNMENT

Government (all levels) is the largest single industry on PEI. It spends approximately one-half of GPP each year and employs over 4,000 people.

Over the last twenty-five years, total real provincial government expenditures have increased by 600%. "In 1949-50 provincial government expenditures represented 14% of the gross provincial product. Today they represent approximately 32% of GPP".[51]

Most economic models treat government variables as exogenous (instruments) or define them in institutional tax collection equations.[52] We have followed suit with specific instrumental expenditures, although government aggregates are estimated.

G1: $PG_{TR} = -12624.3066 + 0.2916\ GPP - 0.2325\ Y_A$

$(R^2 = .9573)$

Provincial government total revenues are a function of GPP (positively) and of total net agricultural income (negatively). The negative coefficient for net agricultural income suggests that as agricultural income declines provincial government revenues increase. Although surprising at first, this can be understood in light of the personal tax contributions of various segments of the PEI population. In 1951, of the 10,100 farmers,

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51 Hon. T.E. Hickey, Budget Speech, 1970, p. 21.

52 See Griliches (1968), p. 38.

100 paid $7,000 in personal income tax. In 1967, of the 6,200 farmers, 623 paid $141,000 in personal income tax. For the same two years pensioners paid $3,000 and $159,000. in personal income tax.[53] It is concluded that as people have moved out of agriculture (and they have quite considerably), those that remain on PEI shift to occupations which contribute greater amounts to the tax collections of the provincial government.

G2: $PG_{TEX} = 1323.0583 + 1.0979\ PG_{TR}$ $(r^2 = .9783)$

Provincial government total expenditures are a function of provincial government total revenues. This equation sets out the aggregate financial constraint on government policies.

G3: $G_{XFR} = 6032.2216 + 0.4957\ PG_{TR} + 578.5051\ T - 0.0848\ GPP$

$(R^2 = .9858)$

Government transfers to persons (from all sources) depend on provincial government total revenues, on time and (negatively) on GPP. Since most transfers pass through the provincial government, this variable is included in the equation. Time represents the changing spectrum of attitudes that allows governments to spend more on transfers and other welfare expenditures. The negative coefficient on GPP represents, as expected, (1) the use of transfers for stabilization purposes and (2) the moderating effects on transfers as general economic conditions improve.

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53 The data source is Department of National Revenue, Taxation Statistics for the years 1951 (TABLE 8, p. 63) and 1967 (TABLE 9, p. 116).

G4: $E_{PG} = 106.8081 + 0.3181\ W_G + 12.765\ T - 0.0123\ PG_{TEX}$

$(R^2 = .9718)$

Employment in the provincial government depends positively on the wage bill and time and negatively on total provincial government expenditures. The positive coefficient of time represents, among other things, the nature of bureaucracy to grow through time.[54] The negative coefficient of provincial government expenditures represents the fact that government revenues have been increasing at a faster rate than government employment and that, on some constant scale, government employees control more funds per capita (an indication of greater competence?).

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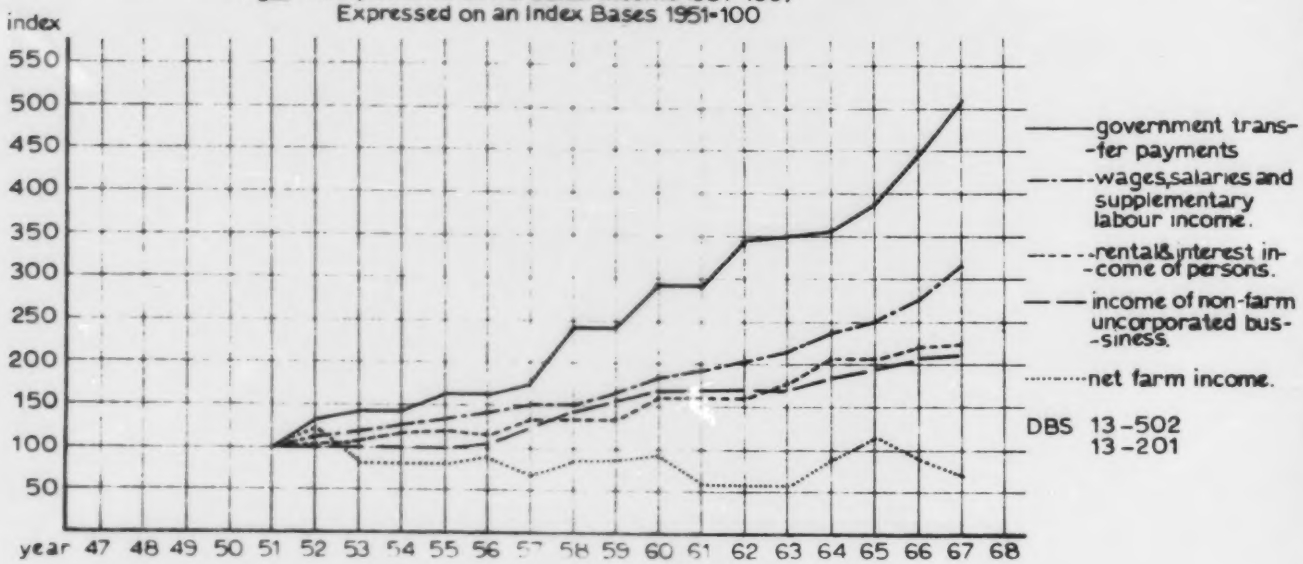
54 See Parkinson, Parkinsons Law, Chapt. 1.

INCOME

Total personal income[55] on Prince Edward Island is approaching the $200 million mark; and personal income per person is now two-thirds[56] of the Canadian figure.

Fig XI Components of Personal Income 1951-1967
Expressed on an Index Bases 1951-100



Not all of the components of total personal income have been increasing with the same regularity and rapidity (Fig. XI). In monetary terms, setting the 1951 data values equal to 100, a comparison with the respective figures for 1967 reveals that government transfer payments have increased fivefold; wages, salaries, and supplementary labor income, threefold; both rental and interest income, and non-farm unincorporated business income have doubled, while net agricultural income has halved.

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55 Defined as: total net farm income plus rental and interest income of persons plus wages, salaries and supplementary labor income, plus income of non-farm unincorporated business plus government transfer payments to persons plus military pay and allowances.

56 One-half, 20 years ago.

Income distribution on Prince Edward Island is slightly more unequal than that in Canada[57]

> "over 57% of total recipients have an annual income below $4,000; 50% of all recipients receive about 15% of total income; and the top 25% of recipients, in the highest income brackets, receive about 60% of total income."[58]

The diagram (Fig. XII) and the table (TABLE 2) on the following page present a concise description of these facts.[59]

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57 According to data derived from the 1961 Census of Canada, Prince Edward Island has the most inequitable income distribution in Canada. The same result is obtained by studying the Department of National Revenue's, Taxation Statistics, for any year. See also Chernick, Interregional Disparities in Income, p. 76-78.

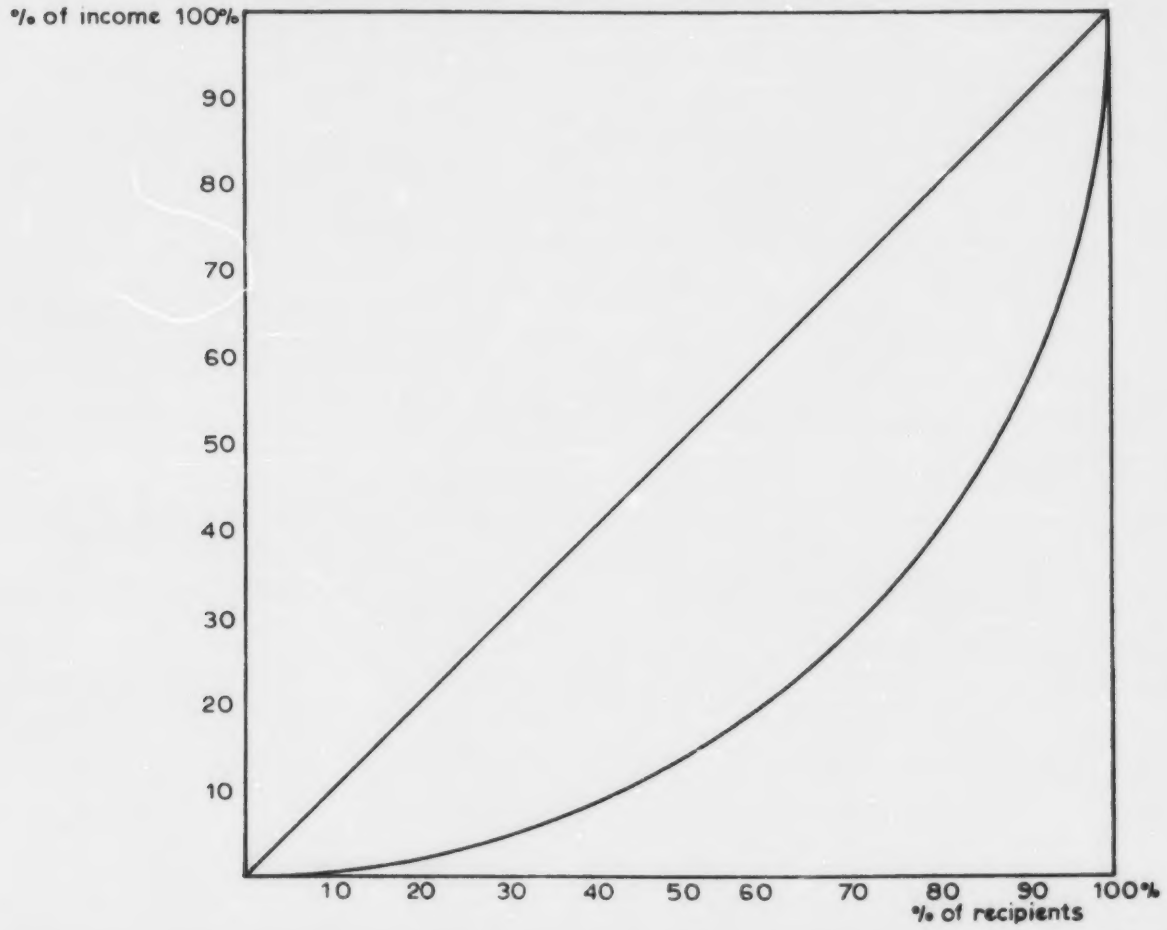
58 Place and Murphy (1969), p. 1.

59 Ibid., p. 9 and 9A.

TABLE 2: PEI PERSONAL INCOME DISTRIBUTION, 1961

INCOME CLASS	% RECIPIENTS IN THIS CLASS	% INCOME REC'D BY THIS CLASS	CUMULATIVE % RECIPIENTS	CUMULATIVE % INCOME
Under $1000	37.92%	8.50%	37.92%	8.5%
1000-1999	21.31	14.00	59.21	22.50
2000-2999	16.22	17.91	75.43	40.41
3000-3999	10.82	16.95	86.25	57.36
4000-4999	5.82	11.72	92.07	69.08
5000-9999	6.44	18.69	98.51	87.77
Over 10,000	1.45	12.22	100.00	100.00

Fig XII PEI INCOME DISTRIBUTION, 1961



Due to the aggregate nature of the data, the components of personal income not previously explained in the model are here estimated in predictive terms using aggregate explanatory variables.

I1: $MPA = -3667.6738 + 0.0002388\ GNP \qquad (r^2 = .9324)$

Military pay and allowances depend on Canadian Gross National Product (GNP).

I2: $Y_{IR} = -1413.1169 + 0.6996\ Y_{IR(t-1)} + 0.0303\ GPP \qquad (R^2 = .9014)$

Net rental and interest income depends on net rental and interest income lagged one year and GPP. The former suggests a demand relationship and the latter suggests Y_{IR}'s dependence on general economic conditions.

I3: $WSS = -9765.6484 + 0.2543\ GPP + 2.986\ VA_M \qquad (R^2 = .9745)$

Wages, salaries and supplementary labor income depends on value added in manufacturing (a proxy for manufacturing income) and GPP (again an indicator of general economic conditions).

I4: $Y_P \equiv Y_A + Y_{IR} + WSS + Y_{NUB} + G_{XFR} + MPA$

Total personal income is defined to equal total net farm income plus rental and interest income plus wages, salaries and supplementary labor income plus income of non-farm unincorporated business plus government transfer payments plus military pay and

allowances.

I5: $\bar{y}_p = Y_p/POP$

Personal income per person is defined as total personal income divided by population.

COMMUNITY WELFARE

The model specifies a sector of community well-being. This sector attempts to approximate and explain the essentially non-quantifiable aspects of the welfare status of PEI's population. It is understood that such approximations may be rough and not defensible in terms of general and/or absolute definitions; but, this is not the reason for their construction.

The welfare indices point out certain "goods", as opposed to "bads" in the system. They suggest that more of a "good" is better than less of a "good". For example, it is assumed that more houses with internal plumbing is better than fewer houses with internal plumbing, and more doctors is better than fewer doctors.

Although overly optimistic the following statement presents the gist of the problem:

> "If we can define social goals fairly carefully, we can usually measure social conditions. The principal barrier to quantification, in the long run at least, is not a lack of meaningful data but a failure to define what is meaningful, to have a clear idea of what we want in various areas of social concern, or to give operational content to our ideals."[60]

The community welfare indices are constructed by means of principal components analysis[61] of which produces a single yearly estimate

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60 Sawhill (1969), p. 478.

61 See p. 8 ff.

for a combination of time series data. This "new" variable is then "fit" in a regression equation.

W1: $JEDCN = -0.2454 + 0.0007\ PG_{ED} + 0.0148\ \bar{y}_P$

$(R^2 = .9667)$

The index of education is a function of provincial government ordinary expenditures on education and personal income per person. The index is a combination of number of teachers per capita, number of university students per capita, and number of high school students per capita[62] with respective weights of one, one and one-third[63]. The explanatory variables are those expected since the index is one of accessibility to education and intuitively

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62 "It is not to be expected, of course, that the education of primary-school children would significantly affect economic growth in the short run. On the other hand, both secondary and higher-level education might be expected to improve the quality of the labor force over a period as short as a decade and thus to contribute positively to short-run economic performance". Adelman & Morris, Society, Politics & Economic Development, p. 124.

63 Harbison & Myers, Education, Manpower, and Economic Growth, Chapter 3, develop an index of levels of human resource development. This index is:

> "simply the arithmetic total of (1) enrollment at second level of education as a percentage of the age group 15 to 19, adjusted for length of schooling and (2) enrollment at the third level of education as a percentage of that age group, multiplied by a weight of 5." (p. 31-2)

Our index is modified to account for the difference between underdeveloped areas where averages are important and our situation where margins are important. Therefore, figures of marginal importance to us must be translated into averages which are subject to noticeable improvements.

the two major determinants should be government educational spendings and personal income per person.

W2: $JHLTH = -660.7316 + 0.0272\ POP_u + 0.0219\ PG_{HLTH} + 0.7546\ HB$

$(R^2 = .9945)$

The index of health services is a function of urban population[64], provincial government total expenditures on health and the number of hospital beds in the province. This index is a combination of number of hospital beds, total hospital personnel and number of doctors.[65]

The interpretation of this equation is clear in the light of the demand (on health services) exerted by an urban(izing) population and supply provided by the provincial government.

W3: $JHSNG = -1414.0637 + 14.9055\ \bar{y}_p + 2.9027\ STRT + 2.7513\ STRT_{(t-1)}$

$(R^2 = .9189)$

The index of housing standards is derived from a combination of (1) number of households with adequate heating facilities, (2) number of households with hot and cold running water, (3) number of households with installed baths and/or showers, (4) number of households with installed flush toilets, and (5) the cumulative number of houses

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64 Defined as: total number of people residing in the greater Charlottetown and Summerside areas.

65 The use of morbidity and mortality rates is not adequate for an explanation of the health status of the population. These rates can be improved only marginally and do not subject themselves to easy interpretation. See Footnote 63.

constructed since 1948. It is a function of personal income per person and housing starts in both this and the last period.[66] Personal income per person enters the equation as an indicator of demand, or capability to demand newer and better housing. The two housing starts variables imply that much replacement (or trade-over) construction is being done and that the newer structures are superior to the older structures (in terms of the standards defined above).

The final index, the index of general well-being of the population combines the other three welfare indices plus personal income per person.

W4: $JWLFR = -671.5286 + 0.4967\ JHSNG + 0.5085\ \bar{y}_p + 0.0336\ POP_u$

$(R^2 = .9999)$

This well-being index is a function (in the short run) of the index of housing standards, of personal income per person, and of the urban population. Other "fits" were attempted and many (combinations of) variables were tried, but this was by far the most satisfactory equation both statistically and intuitively. The implication of this equation, along with the usual conclusions connected with the effects of rising incomes and increasing urban population, is that, on PEI, housing standards are a major and important

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66 This suggests that a form of distributed lag function should be attempted in later stages of updating and revision.

determinant of the general well-being of the population.[67]

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67 The t value for the test of significance of the regression coefficient for the variable JHSNG was 112.8225. Ninety-five percent confidence is achieved with a value of approximately 1.8.

CHAPTER III

THE MODEL: IN ITS ENTIRETY

The model contains forty-two equations, of which thirty-three are statistical and nine are definitional. The nine sectors have been constructed and arranged to depict yearly economic activity as a flow from primary to secondary to tertiary activities.[1] (Fig. XIII).

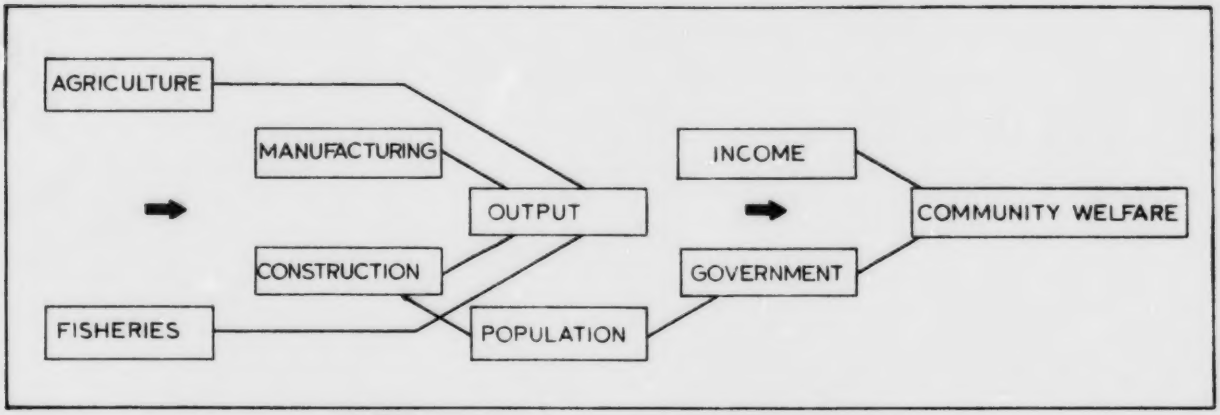

Fig XIII THE MODEL: SECTORAL REPRESENTATION

In this chapter the complete model is presented in three formats:

I. The Complete Model: Equation Form

II. The Complete Model: Matrix Representation Form

III. The Complete Model: Schematic Form

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1 This is not strictly a one-way process since there is feedback in the form of lagged relationships.

I. The Complete Model: Equation Form[2]

The first format presents the equations of the model[3] in sectors, having an alignment similar to that in Fig. XIII. It is in this format that simulation and sensitivity analyses are performed.

Accompanying each equation there are five statistics[4]:

(1) The values for the t test of the regression coefficients. (These appear in parentheses under each respective regression coefficient.) This test signifies whether, with a specified degree of confidence, we may reject the hypothesis that the value of the regression coefficient at hand is not significantly different from zero. All of the regression coefficients in the model are significantly different from zero with greater than 90% confidence, most are significant with greater than 99% confidence.

(2) R^2 or (r^2), the multiple (or simple) coefficient of determination.

(3) SEE, the standard error of estimate.

(4) D-W, the Durbin-Watson statistic (ie., the test for autocorrelation of residuals). In the model, values of this statistic between 1.5 and 2.5 usually suggest acceptability of residuals.

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2 For a graphical presentation of the performance of the statistical equations, see Appendix B.

3 For the naming and titling procedures as well as the names and titles of the variables, see pp. 16-20.

4 For further discussion of R^2 and r^2, SEE, and D-W, see Introduction and Appendix A.

(5) PERIOD OF FIT, the years for which the equation is "fit" (with the number of yearly observations in parentheses).

AGRICULTURAL SECTOR

		R^2	SEE	D-W	PERIOD OF FIT
A1	$F_A = 55.9397 + \underset{(6.858)}{0.6578}\ P_{AC} + \underset{(1.895)}{0.1755}\ P_{A(t-1)} - \underset{(-2.749)}{0.0011}\ Y_{A(t-1)}$	.9462	4.006	0.9877	1947-68 (22)
A2	$K_A = 126326.47 + \underset{(3.739)}{10.6892}\ CDT_A - \underset{(-5.92)}{398.058}\ SQZ_A$	.8619	6734.099	1.8625	1947-68 (22)
A3	$OP_A = 11966.117 + \underset{(4.743)}{0.1366}\ K_A + \underset{(3.013)}{118.1064}\ \%C_A$	.8562	1451.753	1.3376	1946-67 (22)
A4	$\bar{y}_A = -776.6976 + \underset{(10.377)}{0.1368}\ VA_A + \underset{(2.831)}{10.8355}\ F_A - \underset{(-5.808)}{0.0219}\ K_A + \underset{(2.629)}{5.954}\ P_A$	.9629	99.296	1.5812	1946-67 (22)
A5	$Y_A \equiv \bar{y}_A \times \#F$				

INSHORE FISHERY

		R^2	SEE	D-W	PERIOD OF FIT
F1S1	$K_{FIS} = -13.1177 + \underset{(7.954)}{0.6391}\ K_{FIS(t-1)} + \underset{(9.364)}{44.4679}\ P_{FIS(t-1)} - \underset{(-4.973)}{0.6533}\ Y_{UE} - \underset{(-5.265)}{22.3379}\ P_{FL}$	.9328	248.8675	1.7190	1947-68 (22)
F1S2	$E_{FIS} = 3205.6816 - \underset{(-7.827)}{0.23}\ K_{FIS(t-1)} - \underset{(-4.038)}{23.5759}\ P_{FL} + \underset{(4.781)}{30.5421}\ P_{FIS}$	.8650	97.0354	2.4131	1947-68 (22)

OFFSHORE FISHERY

		R^2	SEE	D-W	PERIOD OF FIT
FOS1	$K_{FOS} = 59.8168 + \underset{(7.974)}{0.8101}\ CDT_{FOS} + \underset{(8.483)}{51.6463}\ B_{FOS} - \underset{(-4.556)}{32.2706}\ \pi_{FOS(t-1)} - \underset{(-2.726)}{64.6292}\ C_{FOS(t-1)}$	.9820	92.2058	2.4278	1953-68 (16)
FOS2	$I_{FOS} = K_{FOS} - K_{FOS(t-1)}$				
FOS3	$OP_{FOS} = 45.5082 + \underset{(15.437)}{0.3430}\ K_{FOS} + \underset{(2.049)}{15.523}\ C_{FOS}$	.9589	47.4637	1.6366	1953-68 (16)
FOS4	$E_{FOS} = -17.9909 + \underset{(9.559)}{0.0541}\ OP_{FOS(t-1)} + \underset{(5.232)}{0.0124}\ I_{FOS} + \underset{(3.51)}{0.2695}\ P_{FOS(t-1)} + \underset{(11.727)}{2.9335}\ B_{FOS}$	.9864	3.3727	1.8942	1953-68 (16)
FOS5	$\pi_{FOS} = 2.918 - \underset{(-7.923)}{0.0096}\ K_{FOS} + \underset{(4.82)}{0.004}\ CDT_{FOS} + \underset{(2.308)}{0.2707}\ B_{FOS} + \underset{(2.555)}{0.35}\ \pi_{FOS(t-1)}$	.9518	1.0822	1.6226	1953-68 (16)

	POPULATION	R^2	SEE	D-W	PERIOD OF FIT
P1	$^{e}POP = POP_{(t-1)} + NI\ (POP_{(t-1)})$				
P2	$^{e}L \equiv PPR \times {}^{e}POP$				
P3	$L = 2.3702 + .9223\ {}^{e}L$ (22.774)	.9622	.3154	.7218	1946-68 (23)
P4	$POP = {}^{e}POP - MIG$				

CONSTRUCTION SECTOR

		R^2	SEE	D-W	PERIOD OF FIT
C1	$OP_{CR} = -83910.047 + \underset{(6.912)}{906.0433}\ POP - \underset{(-2.603)}{0.7871}\ MIG - \underset{(-1.795)}{1170.3034}\ \bar{t}(Y_p)$	.9068	1109.283	2.279	1951-67 (17)
C2	$OP_{CI} = 1861.82 + \underset{(9.179)}{1.7133}\ PG_{PW}$	.8069	2130.245	1.765	1951-68 (18)
C3	$OP_{CT} \equiv OP_{CR} + OP_{CI} + OP_{CC}$				
C4	$VA_{CT} = 4335.4287 + \underset{(9.951)}{0.3068}\ OP_{CT}$	.8684	1138.353	1.401	1951-67 (17)
C5	$I_C = 2074.2871 + \underset{(1.821)}{0.1141}\ Y_{IR(t-1)} + \underset{(8.984)}{0.9735}\ OP_{CT} - \underset{(-3.745)}{0.0169}\ GPP$	.8765	174.306	2.289	1951-68 (18)
C6	$W_C = 3909.4428 + \underset{(1.778)}{0.1823}\ VA_{CT(t-1)} + \underset{(5.778)}{2.6377}\ E_C + \underset{(4.321)}{0.5671}\ Y_{IR}$	.9400	694.423	1.707	1951-68 (18)

MANUFACTURING

		R^2	SEE	D-W	PERIOD OF FIT
M1	$\bar{w}_M = -10.6525 + \underset{(3.242)}{0.4417}\ \bar{w}_{M(t-1)} + \underset{(2.69)}{30.0423}\ DCPI + \underset{(3.818)}{0.00007}\ GPP$	.9534	1.2008	1.6604	1948-67 (20)
M2	$W_M^T = -539.6552 + \underset{(3.445)}{0.0207}\ GPP + \underset{(2.903)}{0.2519}\ VA_{M(t-1)} + \underset{(2.441)}{0.2104}\ I_{M(t-1)}$	.9860	173.3397	2.1554	1948-67 (20)
M3	$E_M = 2833.8901 + \underset{(12.174)}{0.2113}\ W_M^T + \underset{(3.320)}{28.4231}\ PS1_M - \underset{(-8.231)}{23.4982}\ PS2_M - \underset{(-3.002)}{13.3712}\ \bar{w}_M$	.9693	38.8427	2.0176	1947-67 (21)
M4	$OP_M = -7435.8603 - \underset{(5.819)}{17.7621}\ E_M - \underset{(-1.756)}{46.2972}\ ESTB_M + \underset{(2.136)}{440.0719}\ JOWN$	.9477	1745.5949	1.3566	1947-68 (21)
M5	$VA_M = -2624.7939 + \underset{(18.865)}{0.3671}\ OP_M$	.9493	612.6864	1.2052	1947-67 (21)

	OUTPUT	R^2	SEE	D-W	PERIOD OF FIT
OP1	GPP = -74353.1564 + 2155.1377 PPR + 0.00332 GNP (3.696) (26.131)	.9822	4929.846	1.612	1946-68 (23)
OP2	$OP_{CP} \equiv OP_A + OP_{CT} + OP_{FOS} + OP_M + OP_{FIS}$				

GOVERNMENT

		R^2	SEE	D-W	PERIOD OF FIT
G1	$PG_{TR} = -12624.3066 + \underset{(17.285)}{0.2916}\ GPP - \underset{(-1.964)}{0.2325}\ Y_A$	.9573	2229.665	.8511	1947-67 (21)
G2	$PG_{TEX} = 1323.0583 + \underset{(31.572)}{1.0979}\ PG_{TR}$	.9793	1917.81	2.0657	1946-68 (23)
G3	$G_{XFR} = 6032.2216 + \underset{(7.153)}{0.4957}\ PG_{TR} + \underset{(5.196)}{578.5051}\ T - \underset{(-2.873)}{0.0848}\ GPP$	.9858	827.816	2.194	1948-68 (21)
G4	$E_{PG} = 106.8081 + \underset{(17.924)}{0.3181}\ W_G + \underset{(1.909)}{12.765}\ T - \underset{(-2.983)}{0.0123}\ PG_{TEX}$	.9718	72.626	1.5307	1946-67 (22)

	INCOME	R^2	SEE	D-W	PERIOD OF FIT
I1	$MPA = -3667.6738 + \underset{(17.024)}{0.0002388}\ GNP$	.9324	763.722	0.768	1946-68 (23)
I2	$Y_{IR} = -1413.1169 + 0.6096\ Y_{IR(t-1)} + 0.0303\ GPP$	.9014	662.493	1.898	1951-67 (17)
I3	$WSS = -9765.6484 + \underset{(2.551)}{0.2543}\ GPP + \underset{(2.434)}{2.986}\ VA_M$	.9745	2749.393	0.985	1947-67 (21)
I4	$Y_P \equiv Y_A + Y_{IR} + WSS + Y_{NUB} + G_{XFR} + MPA$				
I5	$\bar{y}_P \equiv Y_P/POP$				

COMMUNITY WELFARE

		R^2	SEE	D-W	PERIOD OF FIT
W1	$JEDCN = -0.2454 + \underset{(2.666)}{0.0007}\ PG_{ED} + \underset{(4.460)}{0.0148}\ \bar{y}_P$	.9667	1.0514	1.1691	1946-68 (23)
W2	$JHLTH = -660.7316 + \underset{(4.483)}{0.0272}\ POP_u + \underset{(3.229)}{0.0219}\ PG_{HLTH} + \underset{(8.95)}{0.7546}\ HB$	.9945	18.1259	1.2218	1946-68 (23)
W3	$JHSNG = -1414.0637 + \underset{(1.431)}{2.7513}\ STRT_{(t-1)} + \underset{(7.395)}{14.9055}\ \bar{y}_P + \underset{(1.662)}{2.9027}\ STRT$	.9189	1335.0234	1.8142	1952-68 (17)
W4	$JWLFR = -671.5286 + \underset{(112.823)}{0.4967}\ JHSNG + \underset{(8.97)}{0.5085}\ \bar{y}_P + \underset{(4.895)}{0.0336}\ POP_u$	.9999	15.0196	1.4008	1951-67 (17)

II. The Complete Model: Matrix Representation Form

This format (Fig. XIV; back cover insert (yellow)) represents the complete model in a form that visually displays the model's recursive structure[3]. The matrix is interpreted horizontally: each equation has one endogenous variable, the corresponding exogenous variables for which are determined by reading across the line in which that endogenous variable appears, eg. in equation A1, the endogenous variable F_A (average farm size) is a function of P_{AC} (farm cost price index), $P_{A(t-1)}$ (farm product price index in the last year), and $Y_{A(t-1)}$ (total net farm income in the last year).

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3 The matrix of endogenous variables is lower lefthand triangular. See Appendix A.

III. The Complete Model: Schematic Form

The third format (Fig. XV) is a diagrammatic representation of the model. The larger squares represent the endogenous variables and the smaller squares and rectangles represent the exogenous variables. The arrows joining them point out the direction of effect of one variable on another.[4] The solid arrows represent relationships between endogenous variables, the dashed arrows represent relationships between exogenous and endogenous variables, and the dotted arrows represent lagged relationships between endogenous variables (ie., the value of an endogenous variable last year affecting the performance of an endogenous variable this year).

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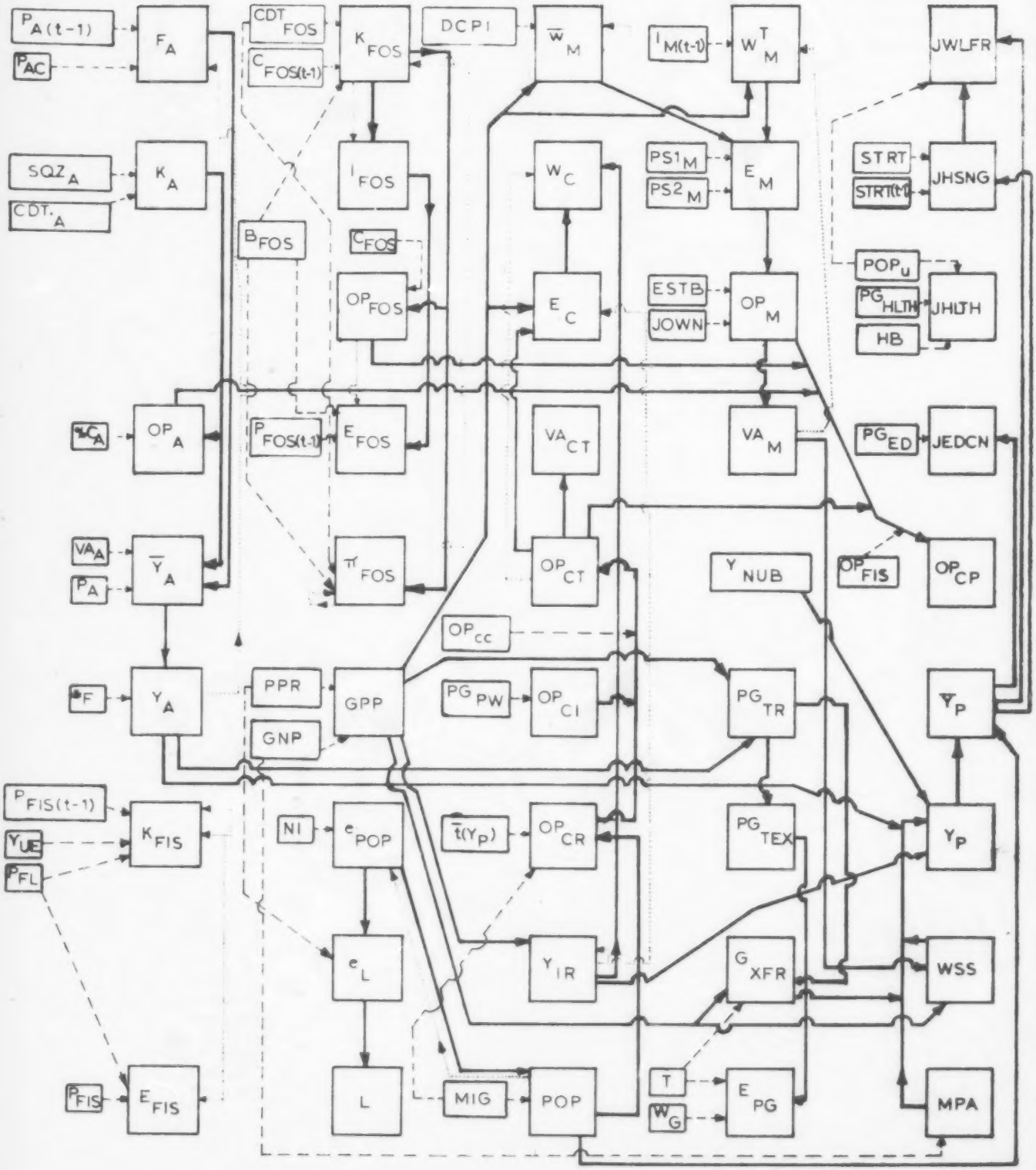
4 See Appendix A, section entitled A Note on the Regression and Correlation Procedure.

Fig XV THE MODEL: SCHEMATIC FORM



CHAPTER IV

SENSITIVITY ANALYSIS[1]

The primary purpose of the model-building exercise, is the construction of a system that can accurately depict economic activity. Once completed, the model may be used to study an entire system, not as it has reacted to events, but as it would have reacted had certain variable inputs differed.

The sensitivity analysis carried on below subjects the entire model (for the year 1961) to the doubling of each exogenous variable, one at a time, and observing the effects on the economy as a whole.

Certain endogenous variables have been designated as primary targets and certain as secondary targets. Certain exogenous variables have been designated as primary instruments (those variables over which the provincial government has, more or less, absolute control) and certain as secondary instruments (those variables over which the provincial government has only indirect or partial control).

There are six primary targets (denoted by "*"):

GPP	-	gross provincial product
Y_P	-	total personal income
JEDCN	-	index of education
JHLTH	-	index of health services

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[1] For a definition of terms and brief introduction to sensitivity analysis, see pp. 11-12.

JHSNG - index of housing standards

JWLFR - index of general well-being

There are five secondary targets (denoted by "**"):

$\bar{y}_A$ - net income per farm

Y_{IR} - net rental and interest income of persons

PG_{TR} - provincial government, total revenues

WSS - wages, salaries and supplementary labor income

OP_{CP} - output, commodity producing sectors

There are seven primary instruments (denoted by "+"):

CDT_A - credit used, agriculture

CDT_{FOS} - credit used, offshore fishery

W_G - total annual wage bill, government

PG_{PW} - provincial government expenditures, on public works (total)

PG_{ED} - provincial government expenditures on education (ordinary)

PG_{HLTH} - provincial government total expenditures on health (ordinary plus capital = total)

HB - number of hospital beds

There are two secondary instruments (denoted by "++"):

I_M - net investment, manufacturing

STRT - number of housing starts

TABLES 3-10 display the results of the sensitivity analysis. Each entry represents the percentage change in that endogenous variable

corresponding to the doubling of that exogenous variable.[2] TABLE 3 matches the six primary targets with those exogenous variables that, when doubled, affect its values. TABLE 4 matches the five secondary targets with those exogenous variables that, when doubled affect its values. TABLE 5 matches the seven primary and two secondary instruments with those endogenous variables that they affect when doubled. TABLES 6-10 present the results of the sensitivity tests for the entire model.

In TABLE 3, four of the primary and the two secondary instruments appear to have some effect on the primary targets. The effects, though, are small compared to the effects of several other exogenous variables (eg. PPR[3] and GNP). The recognized provincial government instruments affect only those segments of the economy that they directly contact.[4] STRT (the number of housing starts) has a strong effect on the housing index which in turn has a large effect on the general well-being index.

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2 The symbol "--" means "not applicable".

3 Concerning the effects of population and labor force participation rates (PPR and LFPR, respectively), both Chernick, op. cit. and Denton, An Analysis of Interregional Differences in Manpower Utilization and Earnings, argue that differences in PPR and LFPR account for upwards of 50% of Canadian regional income differentials. This has important policy implications for all levels of government, since both PPR and LFPR in PEI have consistently been much lower than the Canadian figures.

4 Since this is a short-run model (yearly observations over, at most, 23 years), there is no attempt to capture the longer run effects of these expenditures.

TABLE 3: THOSE EXOGENOUS VARIABLES WHICH, WHEN DOUBLED, AFFECT THE PRIMARY TARGETS

EXOGENOUS VARIABLES	PRIMARY TARGETS					
	GPP	JEDCN	JHLTH	JHSNC	JWLFR	Y_P
P_A		4.7		4.9	4.7	5.6
CDT_A+		-1.0		-1.0	-1.0	-1.1
SQZ_A		4.9		5.1	4.8	5.8
VA_A		9.5		9.9	9.4	11.3
PPR	55.8	25.0		25.9	24.6	29.7
GNP	103.4	54.4		56.5	53.6	64.6
DCPI		-6.7		-7.0	-6.6	-8.0
I_M++		.5		.6	.5	.6
$PS1_M$		9.2		9.6	9.1	11.0
$PS2_M$		-31.2		-32.4	-30.7	-37.1
$ESTB_M$		-7.1		-7.4	-7.0	-8.4
JOWN		13.5		14.0	13.3	16.1
Y_{NUB}		11.3		11.7	11.1	13.4
PG_{ED}+		17.3				
POP_u			104.4		13.6	
PG_{HLTH}+			8.7			
HB +			58.5			
STRT ++				21.7	19.3	

TABLE 4: THOSE EXOGENOUS VARIABLES WHICH, WHEN DOUBLED, AFFECT THE SECONDARY TARGETS

EXOGENOUS VARIABLES	SECONDARY TARGETS				
	$\bar{y}_A$	Y_{IR}	PG_{TR}	WSS	OP_{CP}
P_A	99.6		-6.4		
CDT_A+	-20.4		1.3		1.1
SQZ_A	103.4		-6.6		-5.6
$\%C_A$					4.8
VA_A	200.5		-12.8		
CDT_{FOS}+					.03
B_{FOS}					.3
OP_{FIS}					4.3
PPR		38.9	90.7	46.9	4.4
GNP		72.0	168.0	86.9	8.2
NI					1.7
MIG					.2
$\bar{t}(Y_p)$					-3.7

The secondary targets are similarly affected only to a small degree by the instruments. Only two primary instruments CDT_A and CDT_{FOS} have any effect at all. Once again, the targets are very sensitive to PPR and GNP.

TABLE 5: THOSE ENDOGENOUS VARIABLES THAT ARE AFFECTED BY A DOUBLING, IN TURN, OF EACH INSTRUMENT

ENDOGENOUS VARIABLES	INSTRUMENT VARIABLES								
	CDT_A	CDT_{FOS}	W_G	I_M	PG_{PW}	PG_{ED}	PG_{HLTH}	HB	STRT
K_A	8.3								
OP_A	3.6								
$\bar{y}_A$**	+20.4								
Y_A	+20.4								
K_{FOS}		-20.1							
I_{FOS}		-433.9							
OP_{FOS}		-8.7							
E_{FOS}		-2.7							
FOS		-202.1							
OP_{CI}					88.0				
OP_{CT}					42.4				
VA_{CT}					29.5				
E_C					34.6				
W_C					27.8				
W_M^T				3.5					
E_M				1.8					
OP_M				1.8					
VA_M				2.4					
PG_{TR}	1.3								
PG_{TEX}	1.2								
G_{XFR}	.8								

(TABLE 5 is continued on the following page)

TABLE 5 continued

ENDOGENOUS VARIABLES	INSTRUMENT VARIABLES								
	CDT_A	CDT_{FOS}	W_G	I_M	PG_{PW}	PG_{ED}	PG_{HLTH}	HB	STRT
E_{PG}	-.4		95.1						
WSS				1.3					
Y_P*	-1.1			.6					
$\bar{y}_P$	-1.1	-.04		.6					
OP_{CP}**	1.1			.6	14.1				
JEDCN*	-1.0			.5		17.3			
JHLTH*							8.7	58.5	
JHSNG*	-1.0			.5					21.7
JWLFR*	-1.0			.5					19.3

The nine instruments listed influence a variety of endogenous variables. CDT_A and I_M have effects throughout large portions of the system, while the other instruments have more specific sectoral effects.

The strongest of these sectoral effects is produced by PG_{PW}, which exerts a large influence on values of construction output, value added, employment, and wage bill. A weaker, yet still significant effect is produced by CDT_{FOS} which affects all variables in the offshore fishery sector.

TABLE 6: DOUBLING EACH EXOGENOUS VARIABLE, IN TURN, AND MONITORING ITS EFFECTS (%) ON THE ENDOGENOUS VARIABLES (I)

ENDOGENOUS VARIABLES	EXOGENOUS VARIABLES						
	P_{AC}	P_A	CDT_A+	SQZ_A	$\%C_A$	VA_A	#F
F_A	50.9	17.4					
K_A			8.3	-42.2			
OP_A			3.6	-18.4	15.8		
$\bar{y}_A$**	84.5	99.6	-20.4	-103.4		200.5	
Y_A	84.5	99.6	-20.4	-103.4		200.5	
PG_{TR}**	-5.4	-6.4	1.3	-6.6		-12.8	-6.4
PG_{TEX}	-5.1	-6.0	1.2	-6.3		-12.2	-6.1
G_{XFR}	-3.2	-3.8	.8	-3.9		-7.6	-3.8
E_{PG}	1.5	1.7	-.4	1.8		3.5	1.7
Y_P*	4.8	5.6	-1.1	5.8		11.3	5.6
$\bar{y}_P$	4.8	5.6	-1.1	5.8		11.3	5.6
OP_{CP}**			1.1	-5.6	4.8		
JEDCN*	4.0	4.7	-1.0	4.9		9.5	4.8
JHSNG*	4.2	4.9	-1.0	5.1		9.9	4.9
JWLFR*	4.0	4.7	-1.0	4.8		9.4	4.7

This table displays the strong effects of the price variables on the farm sector and the negative effect on government and total income values.

TABLE 7: DOUBLING EACH EXOGENOUS VARIABLE, IN TURN, AND MONITORING ITS EFFECTS (%) ON THE ENDOGENOUS VARIABLES (II)

ENDOGENOUS VARIABLES	EXOGENOUS VARIABLES						
	P_{FIS}	Y_{UE}	P_{FL}	CDT_{FOS}+	B_{FOS}	P_{FOS}	OP_{FIS}
K_{FIS}	152.9	-36.4	-78.8				
E_{FIS}	93.6		-72.3				
K_{FOS}				10.1	101.8		
I_{FOS}				217.6	2196.1		
OP_{FOS}				8.2	82.7	31.1	
E_{FOS}				1.4	77.5		
FOS				49.2	464.4		
OP_{CP}**				.03	.3		4.3

Similar to the agricultural sector, both of the fisheries sectors are sensitive to prices. CDT_{FOS} has moderate to large effects on the offshore fishery variables which suggests that the provincial government may possess some degree of control over the activities of this fishery.

TABLE 8: DOUBLING EACH EXOGENOUS VARIABLE, IN TURN, AND MONITORING ITS EFFECTS (%) ON THE ENDOGENOUS VARIABLES (III)

ENDOGENOUS VARIABLES	EXOGENOUS VARIABLES						
	PPR	GNP	NI	MIG	$\bar{t}(Y_P)$	W_G+	Y_{NUB}
GPP	55.8	103.4					
e_{POP}			1.7				
e_L	100.0		1.7				
L	93.0		1.6				
POP			1.7	.1			
Y_{IR}**	38.9	72.0					
OP_{CR}			19.7	2.0	-42.7		
OP_{CI}							
OP_{CT}			5.2	.5	-11.3		
VA_{CT}			3.6	.4	-7.8		
E_C	--	--	4.2	.4	-9.2		
W_C	--	--	3.4	.3	-7.4		
$\bar{W}_M$	9.9	18.3					
W_M^T	34.1	63.2					
E_M	13.6	25.2					
OP_M	13.9	25.8					
VA_M	18.1	33.6					
PG_{TR}**	90.1	168.0					
PG_{TEX}	86.1	159.5					

(TABLE 8 is continued on the following page)

TABLE 8 continued

ENDOGENOUS VARIABLES	EXOGENOUS VARIABLES						
	PPR	GNP	NI	MIG	$\bar{t}(Y_P)$	W_G+	Y_{NUB}
G_{XFR}	22.4	41.4					
E_{PG}	--	--				95.1	
MPA		164.7					
WSS**	46.9	86.9					
Y_P*	29.7	64.6	--	--			13.4
$\bar{Y}_P$	29.7	64.6	--	--			13.4
OP_{CP}**	4.4	8.2	1.7	.2	-3.7		
JEDCN*	25.0	54.4	--	--			11.3
JHSNG*	25.9	56.5	--	--			11.7
JWLFR*	24.6	53.6	--	--			11.1

TABLE 8 shows the large effects of the two exogenous variables PPR and GNP, and the more moderate and localized effects of MIG (which in 1961 was +100, meaning that in-migrants to PEI exceeded out-migrants from PEI by 100, a most unusual occurrence), $t(Y_P)$, NI, and Y_{NUB}.

TABLE 9: DOUBLING EACH EXOGENOUS VARIABLE, IN TURN, AND MONITORING ITS EFFECTS (%) ON THE ENDOGENOUS VARIABLES (IV)

ENDOGENOUS VARIABLES	EXOGENOUS VARIABLES					
	DCPI	I_M++	$PS1_M$	$PS2_M$	$ESTB_M$	JOWN
$\bar{W}_M$	60.0					
W_M^T		3.5				
E_M	-22.5	1.8	30.9	-104.4		
OP_M	-23.0	1.8	31.6	-106.7	-24.3	46.3
VA_M	-30.0	2.4	41.2	-139.1	-31.6	60.3
WSS**	-16.2	1.3	22.2	-74.9	-17.0	32.5
Y_P*	-8.0	.6	11.0	-37.1	-8.4	16.1
$\bar{Y}_P$	-7.3	.6	11.0	-37.1	-8.4	16.1
OP_{CP}**	-7.3	.6	10.0	-33.8	-7.7	14.6
JEDCN*	-6.7	.5	9.2	-31.2	-7.1	13.5
JHSNG*	-7.0	.6	9.6	-32.4	-7.4	14.0
JWLFR*	-6.6	.5	9.1	-30.7	-7.0	13.3

The most powerful effects produced by these exogenous variables are those produced by $PS2_M$ and $ESTB_M$. Both produce strong negative reactions to their increase: (1) since, for $PS2_M$, larger firms being more capital intensive in their use of materials, employ less people and thus affect output, income and thus the welfare indexes; and, (2) since, for $ESTB_M$, present patterns prevailing, there would be a re-entry of the smaller and less efficient firms.

TABLE 10: DOUBLING EACH EXOGENOUS VARIABLE, IN TURN, AND MONITORING ITS EFFECTS (%) ON THE ENDOGENOUS VARIABLES (V)

ENDOGENOUS VARIABLES	EXOGENOUS VARIABLES						
	PG_{PW}+	OP_{CC}	PG_{ED}+	POP_{U}	PG_{HLTH}+	HB+	STRT++
OP_{CR}							
OP_{CI}	88.0						
OP_{CT}	42.4	25.5					
VA_{CT}	29.5	17.8					
E_{C}	34.6	20.9					
W_{C}	27.8	16.7					
OP_{CP}**	14.1	8.5					
JEDCN*			17.3				
JHLTH*				104.4	8.7	58.5	
JHSNG*							21.7
JWLFR*				13.6			19.3

In this table, commercial construction output (OP_{CC}) is seen to have a moderate and localized effect on the construction sector; and, urban population (POP_{u}) is seen to have a strong and localized effect on the health and general well-being indexes. (The other variables, all instruments, were dealt with earlier in the chapter.)

CHAPTER V

SUMMARY AND CONCLUSIONS

A brief review of the more important aspects of each sector and the entire model is presented in this chapter.

AGRICULTURE

The most important features of this sector are: (1) the sensitivities of the sector to price fluctuations; (2) the negative relation between capital stock and income (in the income equation); and (3) the conclusion that increasing scale does not suggest increasing net income.

THE FISHERIES

The fisheries are also sensitive to price fluctuations. In the offshore fishery particularly (since there is no parallel data for the inshore fishery) increasing capital and thus increasing scale of enterprise has not led to increased profitability. The conclusions for this sector are closely related to those for the agriculture sector.

POPULATION

Prince Edward Island's population distribution is skewed towards the younger (under 15 years) and older (over 65 years) age groups. Consequently its population participation rate (PPR) is lower than the Canadian PPR which helps to explain some of the income and standard of living disparities.

CONSTRUCTION

Construction is probably the fastest growing industry on PEI. Much of this is due to large provincial government expenditures on (institutional) construction.

MANUFACTURING

The organization (type of ownership and size of plant) plus other general factors in the Island's economic conditions are important variables determining the operation and viability of this sector.

OUTPUT

The general performance of the PEI economy is tied to and depends on the performance of the Canadian economy. PPR also exerts a strong influence on gross provincial product.

WELFARE

The general well-being of Prince Edward Island's citizens (as defined in the model) is dependent on: provincial government expenditures on education and health; personal income per person; the extent of urbanization; and general housing conditions.

As a whole, and in sectors, the PEI economy is highly sensitive to various internal (number of migrants, population participation rate, rate of natural increase, etc.) and external (gross national product, prices and costs to primary producers, average personal income tax rates, etc.) forces. The external forces produce larger and more significant effects on the system than do the internal forces. Although there is some interrelation between sectors, the commodity producing sectors seem to be independent

of each other with respect to output. These findings suggest that the major stimulants of the PEI economy (in terms of inputs and outputs) are the "pull" of external demand and the "push" of total government outlays.

The hypothesis presented in Chapter I,[1] concerning the limitations of the provincial government's direct instruments, has been tentatively confirmed. No direct instrument possesses the capability to significantly affect any target unless favourable conditions prevail in other sectors of the local, and national economies.

Further study may be undertaken in several areas. Almost every equation suggests and contains the potential for more detailed analyses. For example, equation A5, explaining net income per farm, could provide the basis for an analysis of (1) distribution (ownership) of farm capital and (2) institutional farm credit policies; and, equation M3, explaining manufacturing employment, could provide the basis for an analysis of the effects of plant size on economies of scale, manufacturing income, etc.

The most formidable problem of any attempt to undertake a study stemming from one of the model's equations will be the lack of sufficient and reliable data. Barring this constraint, other informative and useful areas that may be studied are:

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1 See section entitled, THE TARGETS-INSTRUMENTS APPROACH, p. 13-15.

(1) government credit policies (in all sectors)

(2) population and migrant characteristics

(3) the commercial service (tertiary) sectors

(4) the tourist industry

(5) the labor market (demand, supply and unemployment)

(6) exports and imports

(7) population consumption habits

(8) provincial government revenues and expenditures

APPENDIX A

METHODOLOGY

In this appendix some points raised briefly in Chapter I will be discussed in a slightly more detailed form.

SPECIFICATION

The specification of relationships that are to be included in any econometric model constitute the basis on which the model is to be built. Due to the nature of any estimation procedure, it is often necessary to discard adequate results (in terms of coefficients of determination, significance of parameter coefficients, and standard errors of estimate) because of incorrect specification. The misspecification of the variables in any equation produces meaningless equations and unsatisfactory explanations of the real structure under examination.

Not only may variables in each particular equation be misspecified; but, the equations themselves may also be misspecified according to choice of endogenous variables or form of regression (e.g. polynomial or log-normal may be the "true" structure although linear is the "fit"). The need to designate endogenous and exogenous variables is a further dimension of the specification problem. In reality there is no such thing as an *exogenous* variable.[1] The terms endogenous and exogenous, therefore, are

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[1] It is difficult, if not impossible, to conceive of any economic variable acting in a vacuum in which it stimulates reactions in other variables and yet is never "exogenously" stimulated itself.

relative and should be seen only as approximations to more rigorous conceptual formulations.

Specification itself is not a rigid or absolute process. Four important factors in the process influence the specification of all models.

1. The understanding, beliefs and biases of the model-builders. An econometric model is, in the strictest sense of the term, a theoretical model; and as such, can include only very few parameters from the vast spectrum of interacting phenomena. Being a (theoretical) model, it is a set of assumptions leading to a theory about, or a representation of, the operation of some real system. But, given the inherent limitations of the analytical method we use to help us perceive and order facts, our criteria of success can only be measured by that degree to which our model correctly explains and approximates the observable relationships of a real-life system.[2]

This is not to say that the methodology used in the model is less exacting or correct than any other operational methodology; we are merely pointing out the inherent human and symbolic limitations of any attempt to explain, describe, predict or prescribe.[3] For

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2 "Every human organism lives in an environment that generates millions of bits of new information each second, but the bottleneck of the perceptual apparatus certainly does not admit more than 1,000 bits per second, and probably much less. Equally significant omissions occur in the processing that takes place when information reaches the brain." H.A. Simon, "Theories of Decision-Making in Economics and Behavioural Science" in A.E.A. Surveys of Economic Theory, Vol. III, p. 19.

3 See footnote 2.

example, equation FIS2 (page 32), states that 86.5% of the changes in inshore fishery employment are explained by variations in; (1) inshore fishery capital stock lagged one year; (2) the lobster price index; and, (3) the inshore fishery price index. Ideally, this equation would also include: (1) the prevailing weather conditions; (2) the attitudes of the fishermen; (3) Jack the Fisherman's argument with his wife on the evening of May 12; (4) Joe the Fisherman's tendency to eat some of his lobster catch before reaching shore; (5) the price of lumber in British Columbia; (6) the cost of wheat in Poland; as well as an infinity of other variables. But it may be argued that there are definite limitations on our activities (e.g., we cannot spend much more than we earn) and that several otherwise excluded variables will balance each other, therefore enabling their exclusion.

2. The availability and length of time series data.[4]

For purposes of estimation, the length of time series data which forms the cement of econometric models is crucial. The *effective sample size* in a regression "involving K independent variables (including a constant term if any) is T - K where T is the actual number of observations. Therefore if T does not exceed K by very much, accuracy of estimation will be very poor."[5] The small size of T frequently leads to the use of Ordinary Least Squares (OLS)

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4 Or number in category, as is the case with cross-section data.

5 Christ, op. cit., p. 431.

estimation in interdependent models.[6] Simultaneous estimation methods, by attempting to estimate the model as a whole, often "run out" of degrees of freedom in cases where K approaches T and cause problems of identification which may prevent the derivation of unique estimates.

3. The purpose of the model.

Econometric models are usually constructed with certain primary objectives in mind. The purpose at hand, whether to be predictive or analytical, which sectors to emphasize, and the eventual use of the model, determine the equation, sector and model specification.

4. The availability of financial resources.

This factor seems to be most important in determining the choice of estimation procedure. The increasing difficulty of calculating the more refined estimators (two stage least squares, full information/ maximum likelihood, the k-class estimators, etc.) is usually the strongest argument against their use in large scale models.

Specification is a complex procedure. To "perfect" the model, each equation would have to be respecified with an infinite number of variables. We would also have to adjust for the fact that decisions are usually made on continuous, rather than

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6 See section on Types of Equation Systems, p. 100

discrete, time scales. The present model uses annual data;[7] whereas a "true" representation would have to: (a) vary the periods of its time series in order to optimally fit the decision-making apparati; and (b) continually adjust time period intervals to better approximate decision-making processes as they exist and as they develop.

TYPES OF EQUATION SYSTEMS

There are essentially two types of equation systems; the recursive form, and the interdependent (or simultaneous) form. Although an extensive literature[8] has been produced concerning the advantages of each of these forms, there is still no general agreement concerning the superiority of either.

Those who would recommend the interdependent system argue against the over-simplicity of a recursive system which portrays economic decisions (actions) as made in a temporal, or chronological, fashion; whereas, decision-(and action-) making should be viewed as a simultaneous process. It is also argued that the necessary assumption for "recursiveness"; that is, independence of all disturbances in any time period,[9] is usually invalid in practice.

On the other hand, those arguing for a recursive system believe

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7 Annual data has the advantage of being in the same period used by government and commerce in their major allocative decisions.

8 See Basmann (1963), Bentzel & Hansen (1954-55), Christ (1960), Fisher (1970), Klein (1960), Strotz & Wold (1960), Wold (1969) and any general text in econometrics.

9 This assumption justifies the use of Ordinary Least Squares (OLS) estimation procedures.

that the above assertions are in error. They maintain that decisions are made in a temporal (period-to-period) fashion and interdependence can even be seen as an error in the specification of the model.[10]

It is admitted that recursive models should perform better the shorter the time period of observation (ie. quarterly data is preferable to annual data) and, since most annual models are run over such short time spans (10-30 years), recursive-model theorists even argue that OLS estimation methods are preferable to other (much more complicated) estimation methods. The OLS estimates are consistent for small samples, where it is often impossible to use the much more complicated simultaneous methods due to the loss of degrees of freedom. Further, simultaneous equation estimation methods are often subject to problems of identification.

The recursive system rests upon four major assumptions:[11]

(1) The structural matrix of endogenous variables is square and has zero values above the principal diagonal (i.e. if we define A as a square r x k matrix, we have

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10 Bergstrom (1966), Dreze & Strotz (1969), Strotz (1960).

11 Assumptions (1) and (2) are necessary for the definition of a recursive system. Assumptions (3) and (4) are needed for the use of OLS estimation procedures.

$a_{rk} = 0$ for all $k > r$).[12]

(2) No current disturbance is correlated with any other current disturbance.

(3) No current disturbance is correlated with any past disturbance.

(4) In any one equation, the exogenous variables are independent of the disturbances.[13]

Recursive systems explicitly indicate the order, direction and effect of economic relationships. They are the only kind of system in which every equation has just one dependent variable,[14] and as such can be solved sequentially. They have thus been labeled "casual-chain" systems.[15] This is seen algebraically by

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12 See footnote 5.

13 In the equation $Y = a + bX + e$, if X and e are significantly correlated then the OLS estimators will be biased and inconsistent. Additionally, if there is any significant correlation between a lagged endogenous variable $Y_{(t-1)}$ and e, then Y is not predetermined and the OLS estimates are again inconsistent. "Intuitively, the reason for this inconsistency is clear. In explaining Y, OLS gives as little credit as possible to the error, and as much credit as possible to the regressor. When the error and regressor are correlated, then some of the effect of the error is wrongly attributed to the regressor." Wonnacott & Wonnacott, Econometrics, p. 153.

14 In any equation, the other dependent variables may be treated as predetermined variables.

15 The term causal here denotes causality only insofar as one can assume causality in any economic relationship. It is the stochastic form rather than the scientific or deterministic form that is implied.

the solution method, which is a direct chain-like or step-by-step process. For instance, in the system:[16]

$$
\begin{aligned}
Y_1 &= a_{11}X_1 + \ldots + a_{1K}X_K + e_1 && (1)\\
b_{21}Y_1 + Y_2 &= a_{21}X_1 + \ldots a_{2K}X_K + e_2 && (2)\\
b_{31}Y_1 + b_{32}Y_2 + Y_3 &= a_{31}X_1 + \ldots a_{3K}X_K + e_3 && (3)\\
&\vdots && \vdots\\
b_{R1}Y_1 + b_{R2}Y_2 + \ldots Y_R &= a_{R1}X_1 \ldots a_{RK}X_K + e_R && (R)
\end{aligned}
$$

where $(Y_1, Y_2, \ldots, Y_R)$ is the vector of endogenous variables, $(X_1, X_2, \ldots X_K)$ is the vector of exogenous and predetermined variables and $(e_1, e_2, \ldots e_R)$ is the vector of disturbances, the solution is achieved by:

(a) directly calculating Y_1

(b) substituting for Y_1 in eq. (2) and thus solving for Y

(c) substituting for Y_1 and Y_2 in eq. (3) and thus solving for Y_3

(d) and so on until Y_R is solved.

---

16 The system as outlined serves as an illustration of assumption (1), with the portions of the equations to the left of the "equals" sign forming a lower left-hand triangular matrix.

This is demonstrated geometrically (Fig. XVI) by placing all the endogenous variables in boxes with arrows showing lines of causation from the "determining" to the "determined" factors. The definition of recursiveness requires that the arrows joining the endogenous variables point in one direction only.

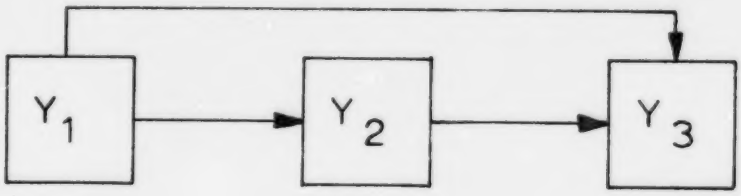

Fig XVI CAUSATION IN RECURSIVE MODELS

In contrast, an interdependent system can be solved by a simultaneous equation solution method. For instance, in the system:

$$Y_1 = a_1 + b_1 Y_2 + c_1 X_1 + e_1 \quad (4)$$

$$Y_2 = a_2 + b_2 Y_1 + c_2 X_1 + e_2 \quad (5)$$

using the same notation as above, the problem of solution is slightly more difficult than that for the recursive system.

Geometrically (Fig. XVII), the arrows of "causation" between the endogenous, or jointly dependent, variables may point in both directions at the same time:

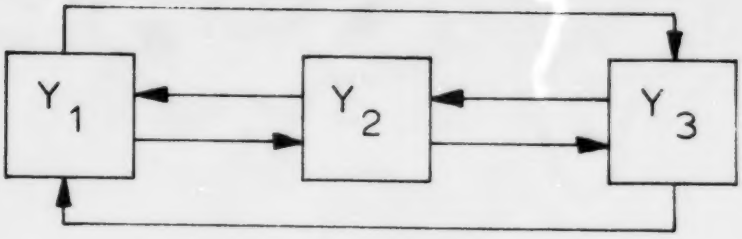

Fig XVII CAUSATION IN SIMULTANEOUS MODELS

IDENTIFICATION

The problem of identification of economic parameters is the problem of setting up a system or model that is sufficiently restrictive so that the parameters are *uniquely* determined.

There are two kinds of problems which may arise. First, there is no unique solution to the equation system:

$$5X + 10Y = 15 \qquad (1)$$

$$10X + 20Y = 30 \qquad (2)$$

since equation (2) is linearly dependent on equation (1)[17].

Second, there is also no unique solution to the system:

$$5X + 10Y = 15 \qquad (3)$$

$$3X + 8Y + 3Z = 21 \qquad (4)$$

In systems of equations similar to (1) & (2), and (3) & (4) there exists an infinity of acceptable solutions. In econometrics,

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17 i.e.[eq. (2)] = 2[eq. (1)].

> "the idea of identifiability refers to the issue of whether the model is just sufficiently restrictive so that when it is confronted with the data, just one hypothesis is consistent with both model and data."[18]

Further,

> "unidentification occurs when a given set of disturbances and exogenous variables may be 'passed through' several different structures, each yielding the same values for the endogenous variables. In this case, the true structure cannot be identified from a whole set of bogus structures".[19]

The conclusion that recursive-form parameters are always identified follows logically from an observation of the preceding two problems.[20] Since there is no form of recursive model which does not yield a unique solution (by operation of the system) problems that may arise in simultaneous systems cannot appear in recursive systems.

ESTIMATION

The estimation problem is probably the most interesting theoretical problem in econometrics. It concerns the question of what is the best estimator to use for any specific situation.

Estimation, as a problem and as a procedure arises because most analyses attempt to reveal certain facts about a "structure" (e.g., the PEI economy), having only a small portion of derived

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18 Christ, op. cit., p. 300.

19 Wonnacott & Wonnacott, op. cit., p. 189.

20 For a more detailed theoretical discussion of this point, see A.S. Goldberger, Econometric Theory, p. 383.

data to deal with. In statistical terms this is the problem of estimating a *population* parameter from the information derived from a *sample* drawn from that population. Using both *a priori* and sample information, the estimation problem[21] becomes one of deciding upon one *action* (or estimate) from among all the possible actions (or estimators). The choice of one particular *action* (estimator) defines certain specific operations on the sample.

Selecting a random sample $(X_1, X_2, X_3 \ldots X_n)$ we have[22]

$$A = D(X_1, X_2, X_3 \ldots X_n)$$

where A is the "action space", i.e., the realm of all possible actions. In other words, the decision to take action a[23] where $a = d(x_1, x_2, x_3, \ldots x_n)$ depends on d[24]. The decision function d determines the form of action that will be undertaken (i.e., it defines the estimators to be used).

Once a spectrum of possible decisions and therefore actions is understood or defined, it becomes necessary to establish criteria that discriminate among various decision functions. This is done

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21 See A.M. Mood and F.A. Graybill, Introduction to the Theory of Statistics, p. 161-197.

22 Most of the following notation is similar to that used in Mood and Graybill, ibid.

23 Where a is in the action space A (or $a \in A$).

24 Where d is in the decision space D (or $d \in D$).

by the evaluation of the terminal actions of these decision functions for any one problem. To do this we introduce a loss function $L(a;\theta)$[25] which indicates the loss incurred by taking action a where θ is the true parameter. Obviously the loss is zero when a produces an estimate ($\hat{\theta}$) of θ such that $\hat{\theta} = \theta$. To each loss function, there corresponds a risk function $R(d;\theta)$[26] such that the risk is the expected value of the loss function.[27] A "good" decision function can now be seen as one which minimizes the risk associated with estimating θ.

Since there is no *a priori* method whereby we can specify the "true" loss function, any number of loss functions may be specified. By convention most loss functions are of the form

$$L_\theta = (\hat{\theta} - \theta)^2$$

where the decision function d produces the estimator $\hat{\theta}$.[28] This loss function indicates that the loss increases geometrically, the further the difference between $\hat{\theta}$ and θ.[29]

The estimation problem can now be defined as one of searching for

---

[25] or L_θ

[26] Or R_θ

[27] i.e. $R(d;\theta) = E[L(a;\theta)]$

[28] This may be represented by $\theta = d(X_1, X_2, X_3, \ldots X_n)$

[29] Other examples of loss functions: (1) $L_\theta = (\hat{\theta} - \theta)$
(2) if $(\hat{\theta} - \theta) > n$; then $L = 0$
if $(\hat{\theta} - \theta) < n$; then $L = 1$

a suitable decision function d which minimizes the risk function:

$$R_{\theta} = E[(\hat{\theta} - \theta)^2]$$

Thus the problem of selecting an estimator with minimum risk resolves into the problem of finding that estimator which minimizes the quantity $E[\hat{\theta} - \theta)^2]$.[30] Algebraically, $\hat{\theta}_1$ is considered to be more efficient than $\hat{\theta}_2$ if

$$\frac{R(d_1,\theta)}{R(d_2,\theta)} < 1$$

Unfortunately, in any applied problem,

> "there does not exist an estimator which minimizes the mean-squared error for all values of θ, but one estimator may produce a minimum mean-squared error for some values of θ and another estimator may produce a minimum mean-squared error for other values of θ".[31]

It is therefore necessary to choose estimators that possess adequate properties for the purposes at hand.

Four desirable properties of any estimator are:

(1) Unbiasedness (U)

(2) Consistency (C)

(3) Asymptotic Efficiency (AE)

(4) Minimum-Variance Unbiasedness (MVU)

1. Unbiasedness: An estimator $\hat{\theta}$ is unbiased if the expected value of $\hat{\theta}$ equals θ, i.e., if $E(\hat{\theta}) = \theta$.

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30 This quantity $E[(\hat{\theta} - \theta)^2]$ is called the *mean-squared error* (MSE).

31 Mood and Graybill, op. cit., p. 166.

2. Consistency: An estimator $\hat{\theta}$ is consistent if the risk associated with using it decreases to zero as the sample size increases.[32]

$$\lim_{n \to \infty} E[(\hat{\theta} - \theta)^2] = 0$$

In other words if 0 is a consistent estimator, it will be better if it is based on fifty observations than if it is based on five observations.

3. Asymptotic Efficiency: An estimator $\hat{\theta}_1$ is asymptotically efficient if there is no other estimator $\hat{\theta}_2$ that possesses a smaller MSE at the limit.[33]

$$\lim_{n \to \infty} \frac{E[(\hat{\theta}_1 - \theta)^2]}{E[(\hat{\theta}_2 - \theta)^2]} < 1$$

4. Minimum-Variance Unbiasedness: An estimator $\hat{\theta}$ is minimum-variance unbiased if it satisfies two conditions:

(i) it is unbiased, i.e., $E[\hat{\theta}] = \theta$.

(ii) its variance is less than the variance of any other estimator.

Although this property may seem trivial or redundant in the face of other properties, it does serve an important function.

> "Consistent estimators, BAN estimators,[34] and efficient estimators have optimum properties when the sample size is large, but the property minimum variance unbiased is optimum for any

---

32 Note that possessing this squared-error consistency implies that the bias of the estimator must also approach 0.

33 Note that possessing this squared-error asymptotic efficiency implies that the estimator must also be consistent.

34 *Best asymptotically normal*, ibid., p. 174.

> sample size. Even though minimum-variance unbiased estimators are not as desirable as minimum mean-squared-error estimators, they frequently exist, whereas minimum mean-squared-error estimators rarely do."[35]

The mean-squared error $(\hat{\theta} - \theta)^2$ then, depends on the degree to which various estimators possess the above four properties, consequently the estimation problem becomes one of choosing the "best" estimator, i.e., the one which minimizes MSE subject to the (data, financial and other resource) constraints at hand. Symbolically,

$$L = f(\hat{\theta} - \theta)^2$$

where[36] $(\hat{\theta} - \theta)^2 = f(U,C,AE,MVU)$

In our case, the OLS procedure produces unbiased and consistent estimators. Further, if the disturbances in each equation are normally distributed, OLS estimators become the maximum-likelihood estimators; and as such, they are also asymptotically efficient.

The above, more theoretical, properties are those necessary to justify the choice of estimation procedure. Needless to say, there also exist more technical and applied problems. These problems can be divided into four categories:

(1) Multicollinearity

(2) Autocorrelation of Residuals

(3) Misspecification

(4) Poor Data and Data Limitations

1. Multicollinearity: The existance of multicollinearity, the

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35 Mood and Graybill, op. cit., p. 176.

36 The expression that follows is useful for understanding the process. It has no algebraic meaning.

problem of high correlation between some or all of the explanatory variables in an equation, invalidates the assumption that the explanatory variables in any equation are linearly independent. This may result in the inability of the OLS solution method to produce unique estimates of the regression coefficients ($a, b_1, b_2, \ldots, b_n$) For example, multicollinearity occurs with a high value of r_{12} [37] in the following equation:

$$Y = a + b_1X_1 + b_2X_2 + e$$

Multicollinearity has a negative effect on all estimation procedures and occurs (to some extent) in all econometric models. It may arise through misspecification of the model's equations (either including "wrong" or excluding "true" variables) or by inferior data. It decreases the reliability of the individual regression coefficients, blurs the effects of the individual explanatory variables and makes them seem to act always in unison.

Thus the greater degree of multicollinearity in any equation; (1) the more unreliable the estimates, (2) the greater the sensitivity of parameters to variable specification, and, (3) the higher the standard errors of the regression coefficients. "Multicollinearity must, therefore, be regarded as a 'black mark' that reduces our confidence in con-

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37 r_{12} here denotes the simple correlation coefficient between X_1 and X_2.

ventional tests of the significance of the various b_i".[38]

2. Autocorrelation of Residuals: One important assumption justifying OLS estimation procedures is the independence of successive disturbances. If this does not obtain, we find that our estimators will still be unbiased and possibly consistent, but they will lose efficiency and will exhibit large variances.[39] Further, lagged endogenous variables will no longer be predetermined, the regression residuals will no longer approximate the theoretical errors,[40] and the standard error and significance tests will become almost meaningless.

The usual method of detecting autocorrelation is the calculation of the Durbin-Watson statistic (D-W).[41,42] Once detected, significant autocorrelation can be extremely difficult to remove.

> "there are mathematical techniques available for dealing with the problem, but their practical applicability in econometric work may be open to doubt. Autocorrelated errors may

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38 E.J. Kane, Economic Statistics & Econometrics, p. 278.

39 Although they may still remain relatively the most efficient. See ibid., p. 361 and Wonnacott and Wonnacot, op. cit., p. 153.

40 If they ever were or ever can; but this is meant only in a statistical sense.

41 Durbin, J. and Watson, G.S. (1950, 1951).

42 The D-W statistic, however, is inappropriate in many cases and must be used with caution (especially where lagged endogenous variables appear in the equation).

> indicate that there is something wrong with the specification of the relationship, and the task is to correct this until random residuals are obtained. In particular, the regression may not be linear in the original variables, and they may have to be transformed; or else an important variable influencing y has been excluded, and multiple regression is called for. Alternatively, the error specification may be incorrect, and a transformation to first difference will help".[43]

3. Misspecification: Already noted several times, misspecification often has a deterimental effect on estimation procedures. It can cause multicollinearity and autocorrelation or may work more directly to modify the positive properties of any estimator. Another example of the effects of misspecification (in addition to those mentioned above in (1) and (2)) is the problem that if disturbances are not independent from period to period, then estimators of lagged endogenous variables may lose consistency.[44]

4. Poor Data and Data Limitations: Both poor data and data limitations will have much the same effect on estimators as does misspecification. Lack of data on certain variables may lead to the substitution of proxy variables as well as other concomitant assumptions. Inconsistent data will usually make a total shambles of any attempt at useful estimation.

In summary, the estimation procedure may be portrayed as a process

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43 C.E.V. Leser, Econometric Techniques and Problems, p. 17.

44 See Christ, op. cit., p. 481.

consisting of nine steps:

1. Information required (about some population; data in form of samples is available).
2. Recognition of range of possible actions (estimators).
3. A certain loss (risk) is associated with each action (estimator). This loss (risk) depends upon
   a. Unbiasedness
   b. Consistency
   c. Asymptotic efficiency
   d. Minimum-Variance unbiasedness
4. Decision problem (minimizing a specified loss (risk) function).
5. Choice of action (estimator).
6. Estimation of equations.
7. Search for further problems,
   a. Multicollinearity
   b. Autocorrelation
   c. Misspecification
   d. Poor data and data limitations
8. Re-estimation in light of step 7, if necessary.
9. Final equation presentation.

A Note on the Regression and Correlation Procedure

In the following statistical equation

$$Y = a + bX$$

where Y is the estimated endogenous variable; X, the exogenous variable; a and b, the regression coefficients; r^2, the co-

efficient of determination;[45] and SEE, the standard error of estimate,[46] the statistics a, b, r^2 and SEE measure the *association* between X and Y but say nothing about the *casual relationship* between them.[47] Yet it is this very relationship that we infer when we set up an equation for estimation.

Since the regression and correlation procedure does not provide information concerning the cause-effect status of any relationship, it is the duty of model-builders to estimate only those relationships that are meaningful in a cause-effect sense.[48] It is only too easy to set out relationships which manifest high r^2's but tell nothing useful about any cause-effect process. For example, an r^2 of .95 for a regression of car tire size on government revenues or of South American oil exports on PEI potato production is meaningless if the relationship desired is one of cause-effect. Of course these are extreme samples; in practice the matter of discrimination between valid and spurious relationships becomes more difficult and only by possessing a reasonable working knowledge of the economy in question combined with good theory and sound intuition can we attempt to clarify these issues.

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45 Where r^2 is equal to or greater than 0 but less than or equal to one, i.e., $0 \leq r^2 \leq 1$.

46 Where SEE is equal to or greater than 0, i.e., $SEE \geq 0$.

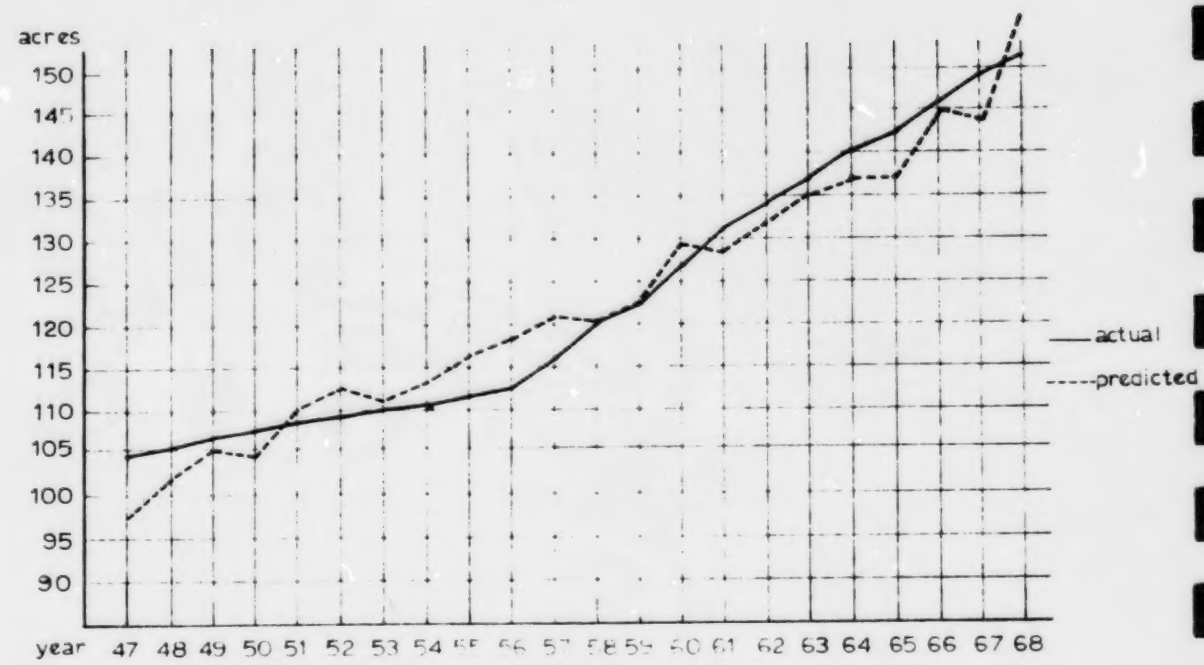
47 In a regression relationship of any form the inference made is that changes in the independent (exogenous) variable(s) are responsible for and *cause* changes in the dependent (endogenous) variable, i.e., $X \rightarrow Y$.

48 This clearly points out the importance of proper equation specification and the pervasiveness of the specification problems.

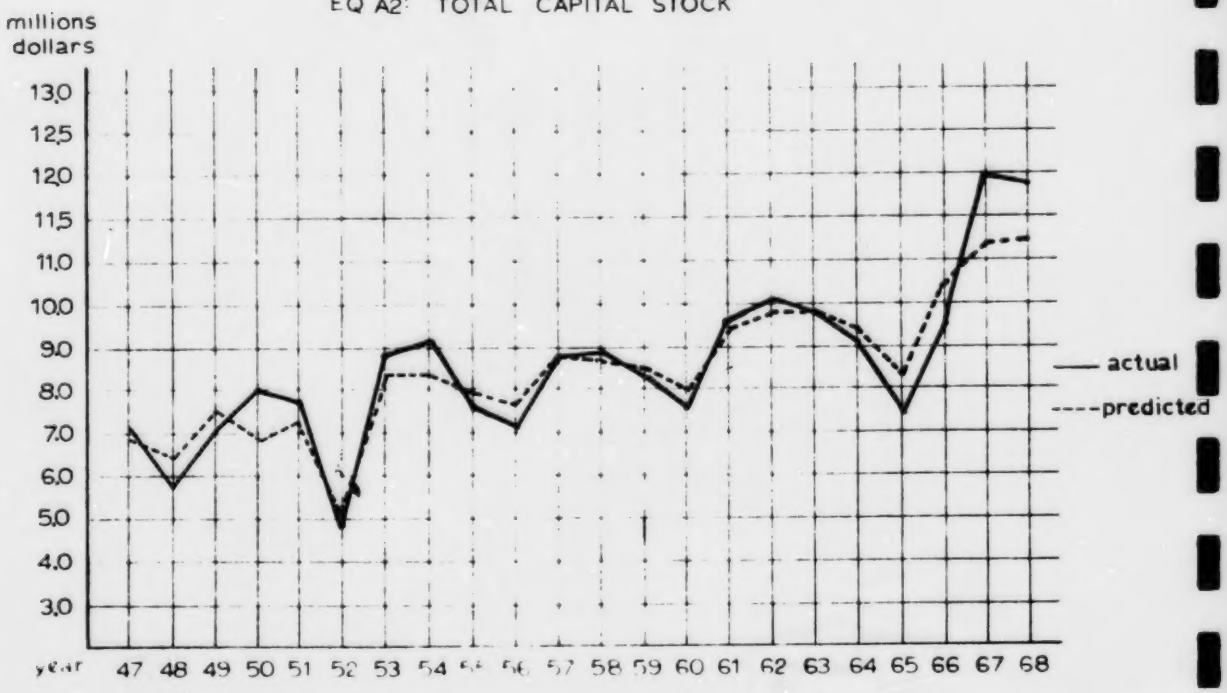
APPENDIX B

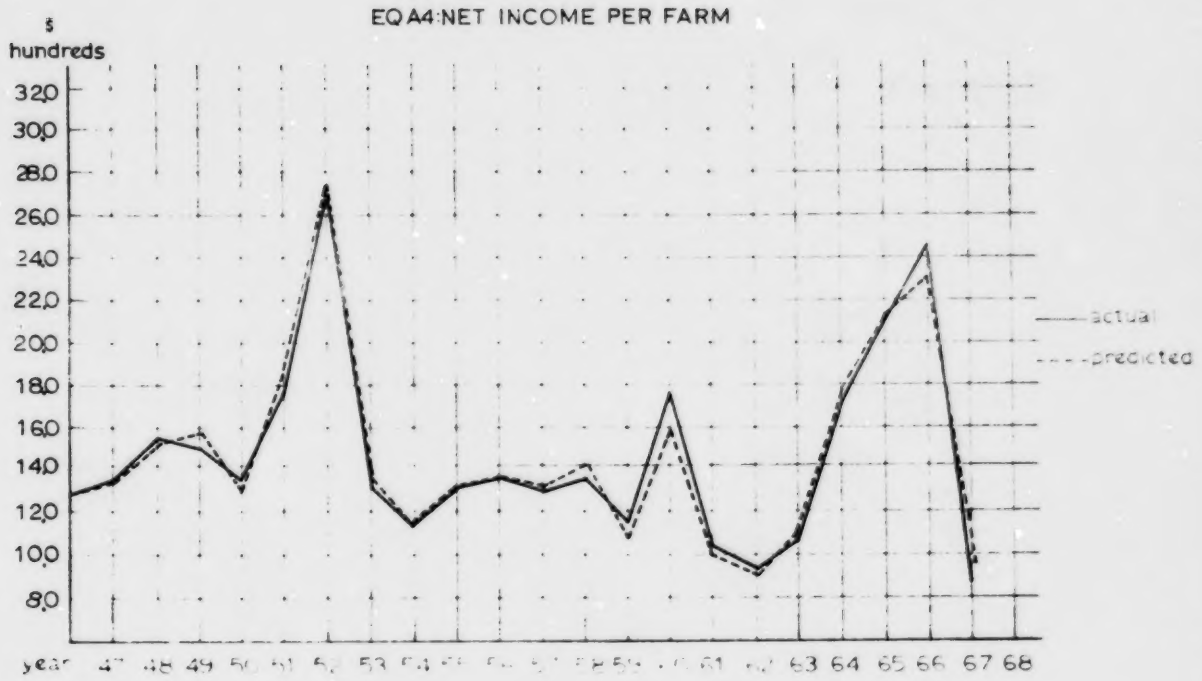
PERFORMANCE OF EQUATIONS: ACTUAL AND PREDICTED VALUES

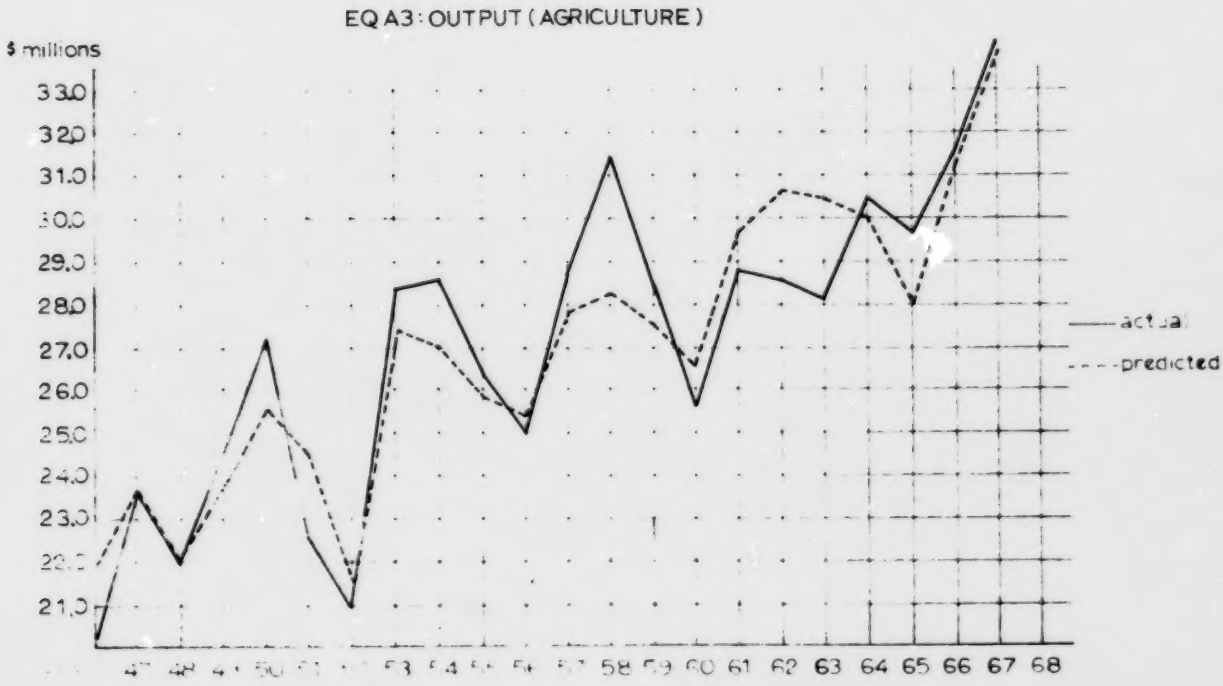
EQ A1: ACTUAL FARM SIZE



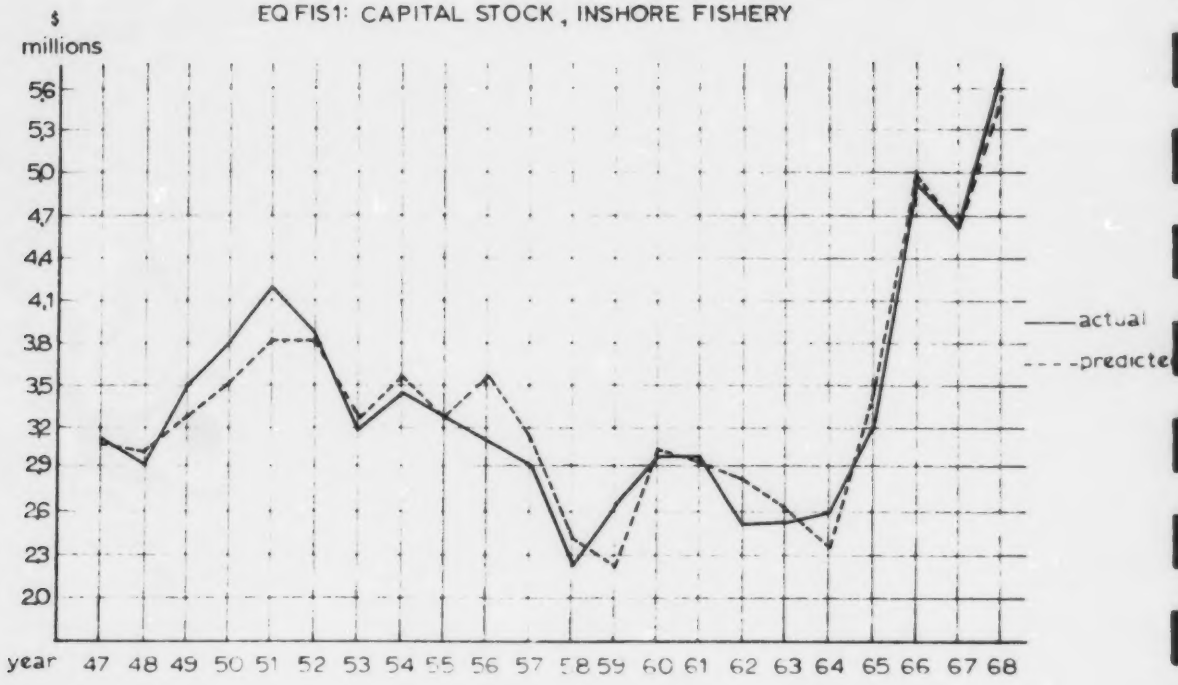
EQ A2: TOTAL CAPITAL STOCK



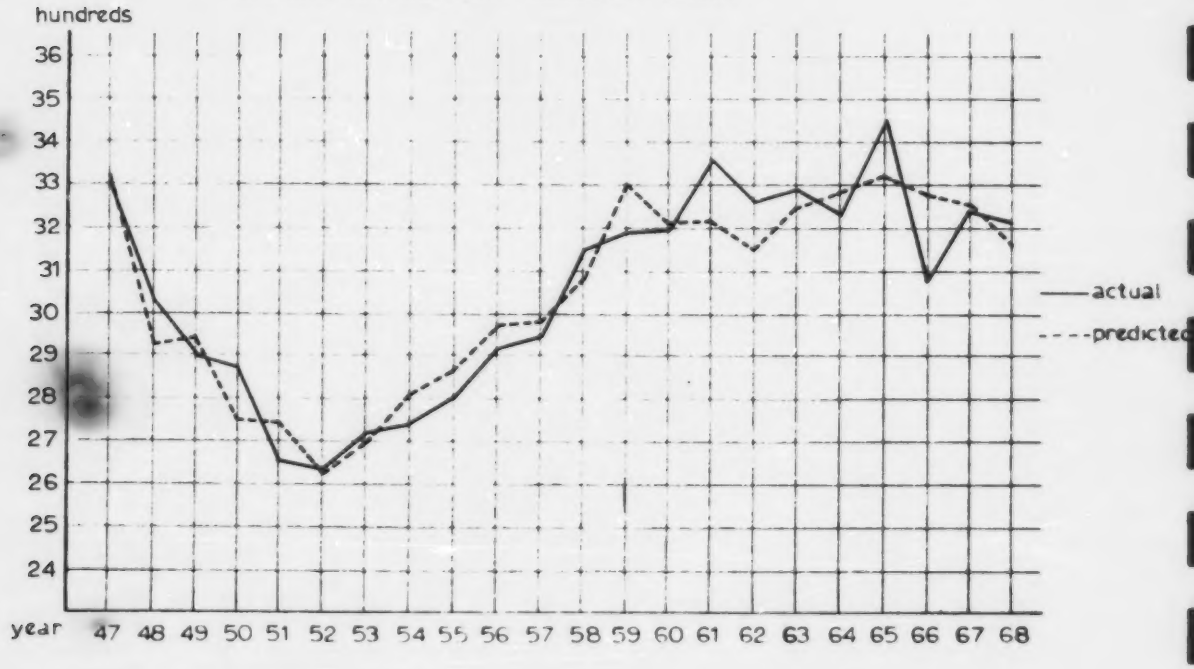

EQ A4: NET INCOME PER FARM
$ hundreds
32.0
30.0
28.0
26.0
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
year
63 64 65 66 67 68
actual
predicted

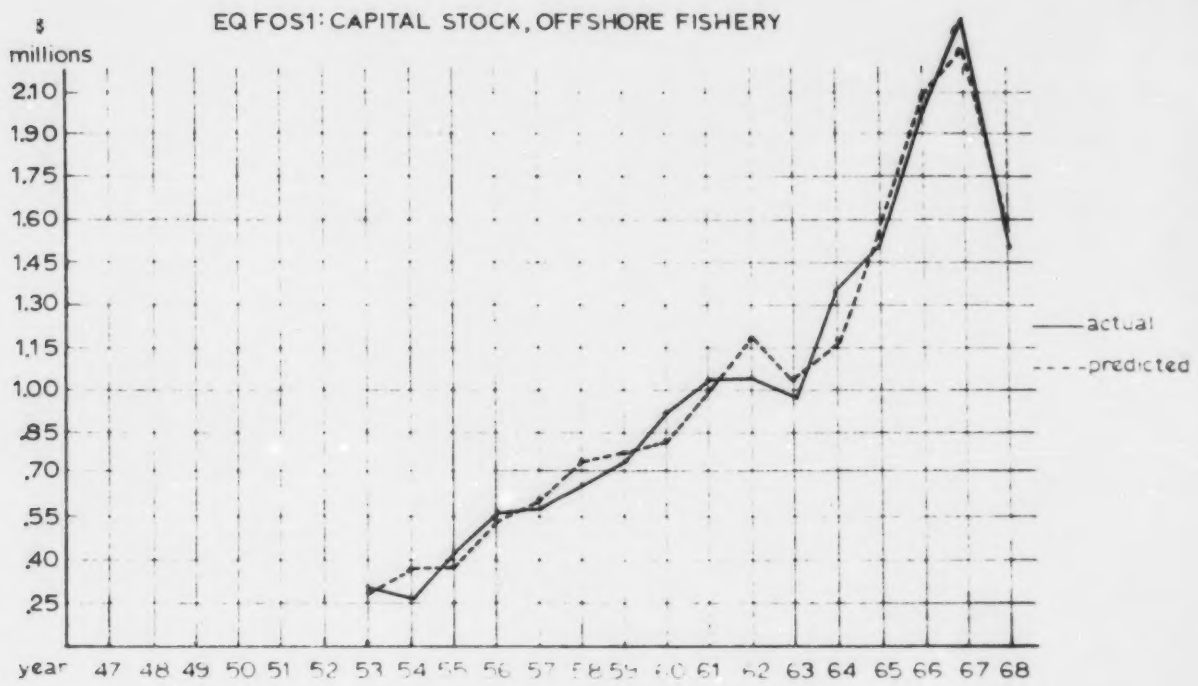

EQ A3: OUTPUT (AGRICULTURE)
$ millions
33.0
32.0
31.0
30.0
29.0
28.0
27.0
26.0
25.0
24.0
23.0
21.0
58 59 60 61 62 63 64 65 66 67 68
actual
predicted

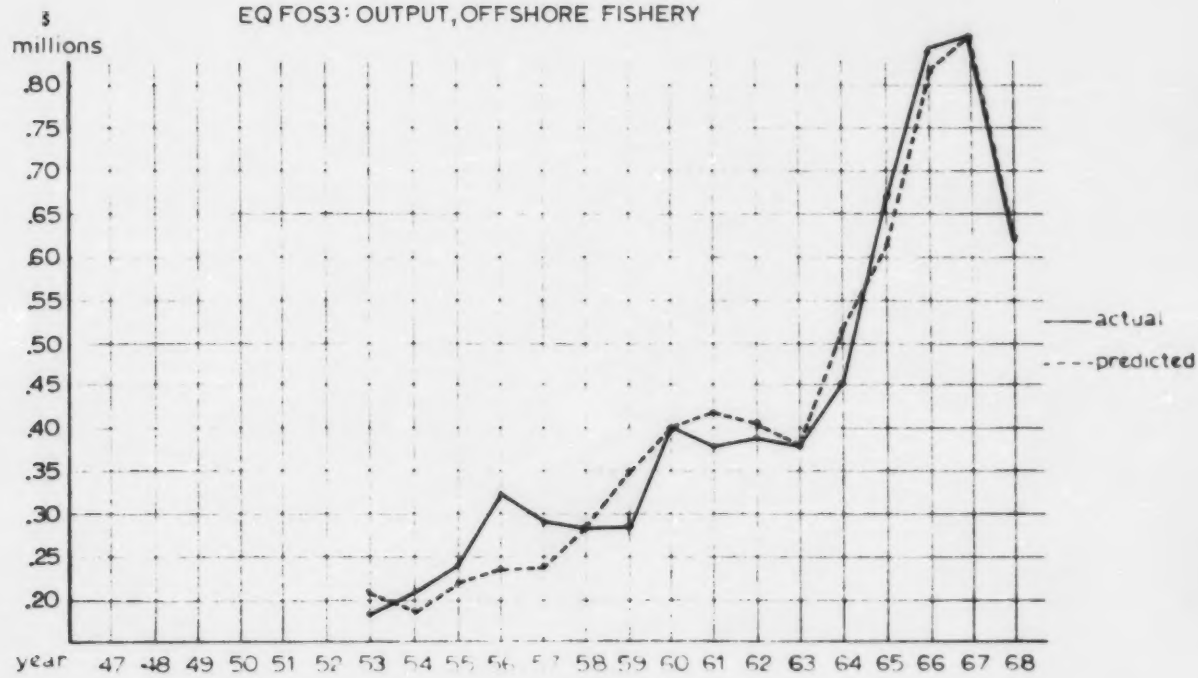
EQ FIS1: CAPITAL STOCK, INSHORE FISHERY



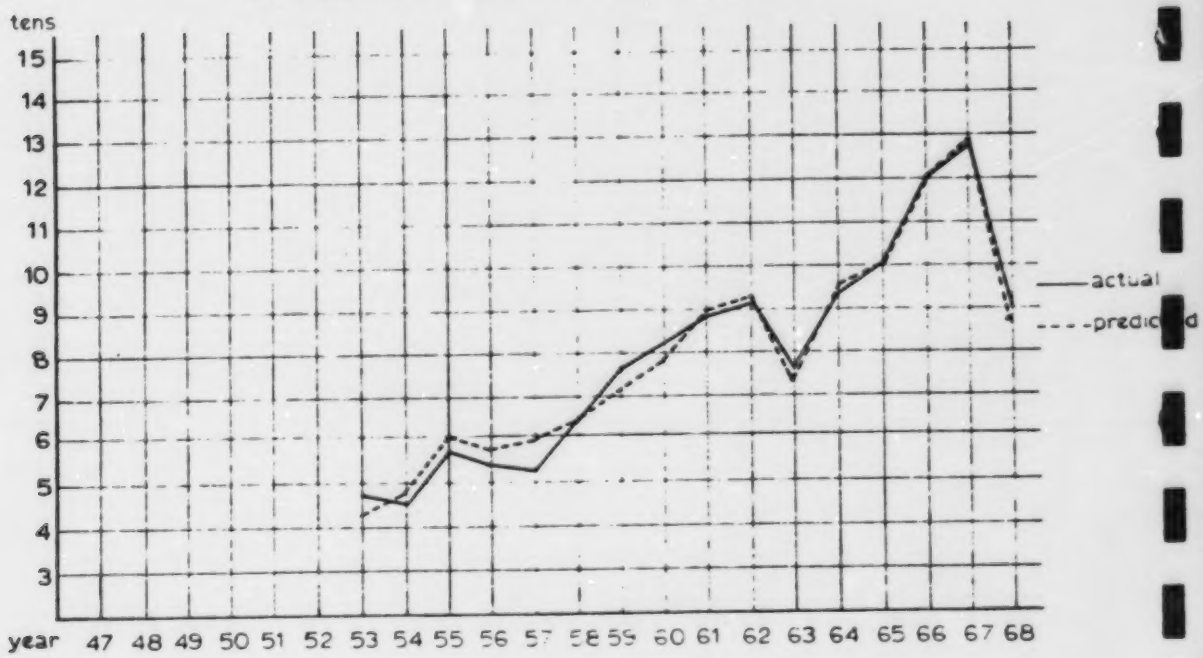
EQFIS2: EMPLOYMENT INSHORE FISHERY



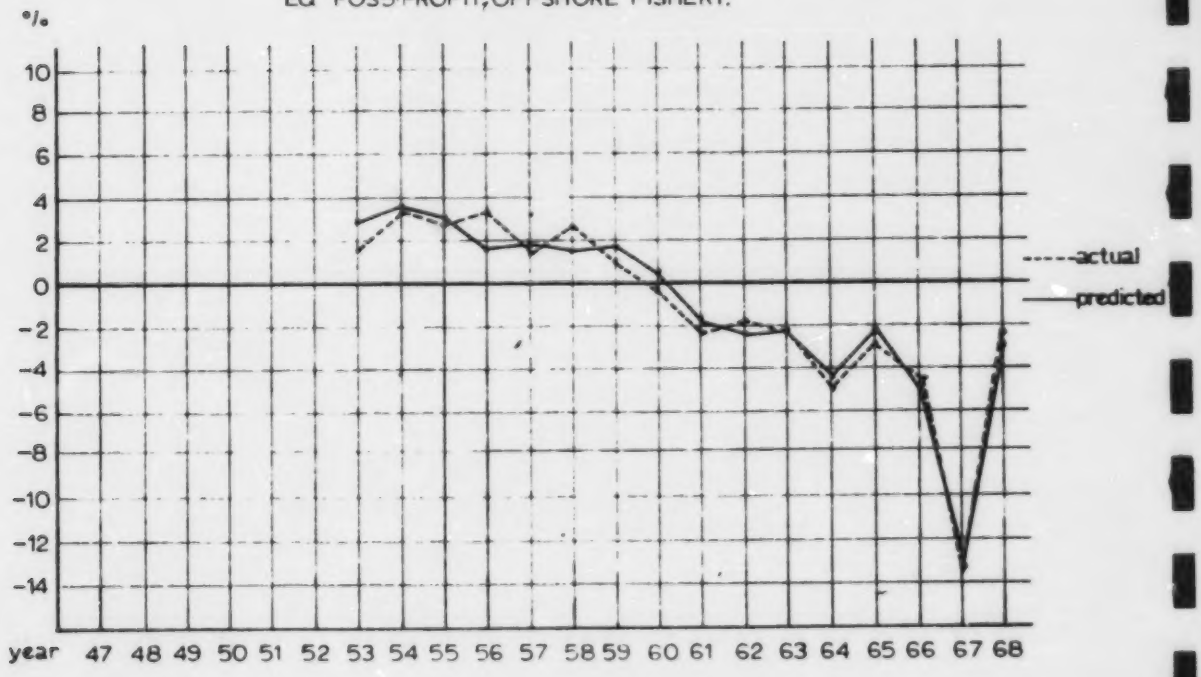

EQ FOS1: CAPITAL STOCK, OFFSHORE FISHERY
$ millions
2.10
1.90
1.75
1.60
1.45
1.30
1.15
1.00
.85
.70
.55
.40
.25
year 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
actual
predicted


EQ FOS3: OUTPUT, OFFSHORE FISHERY
$ millions
.80
.75
.70
.65
.60
.55
.50
.45
.40
.35
.30
.25
.20
year 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
actual
predicted

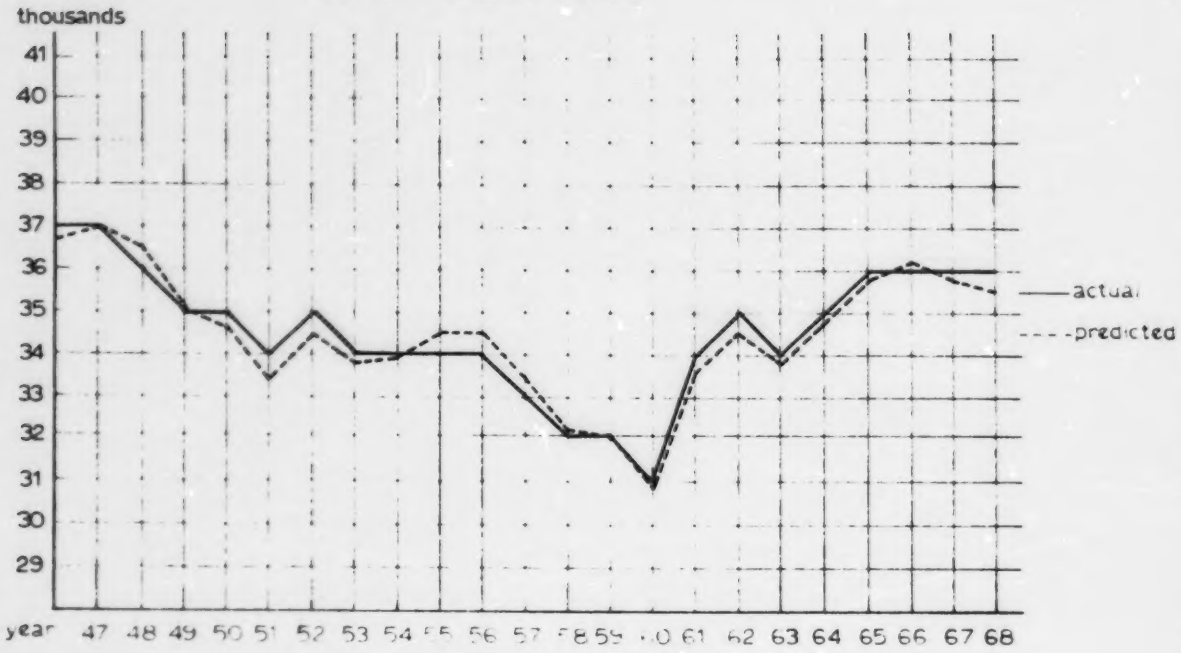
EQ FOS4: EMPLOYMENT, OFFSHORE FISHERY



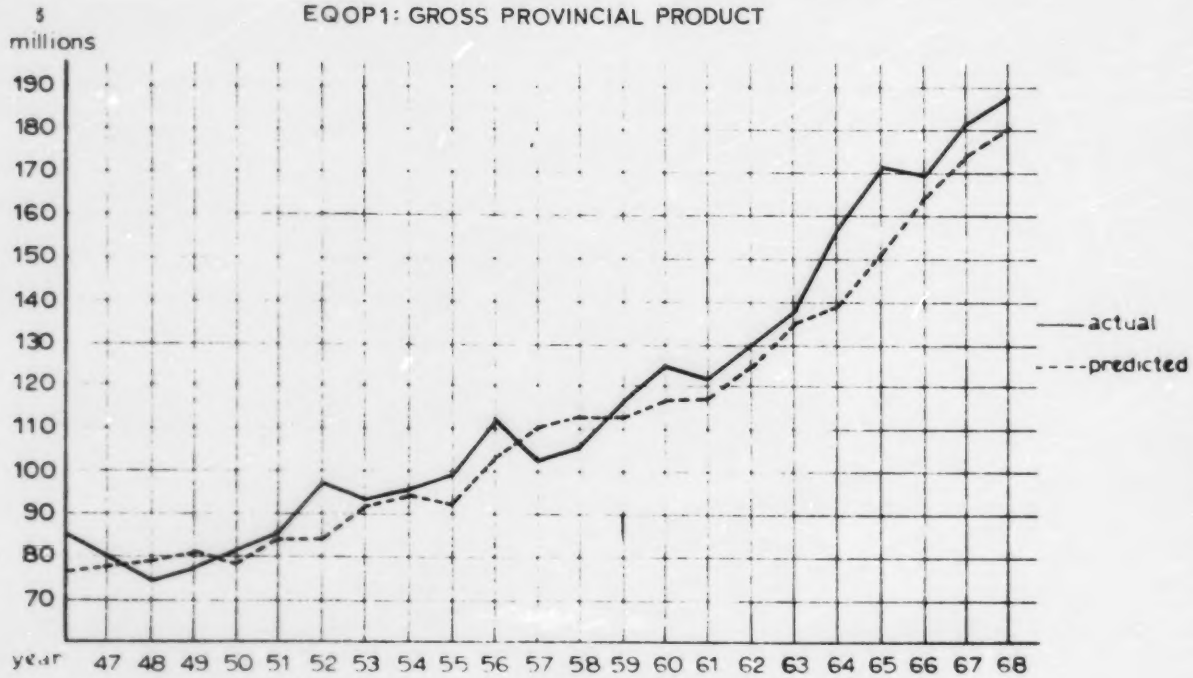
EQ FOS5: PROFIT, OFFSHORE FISHERY.

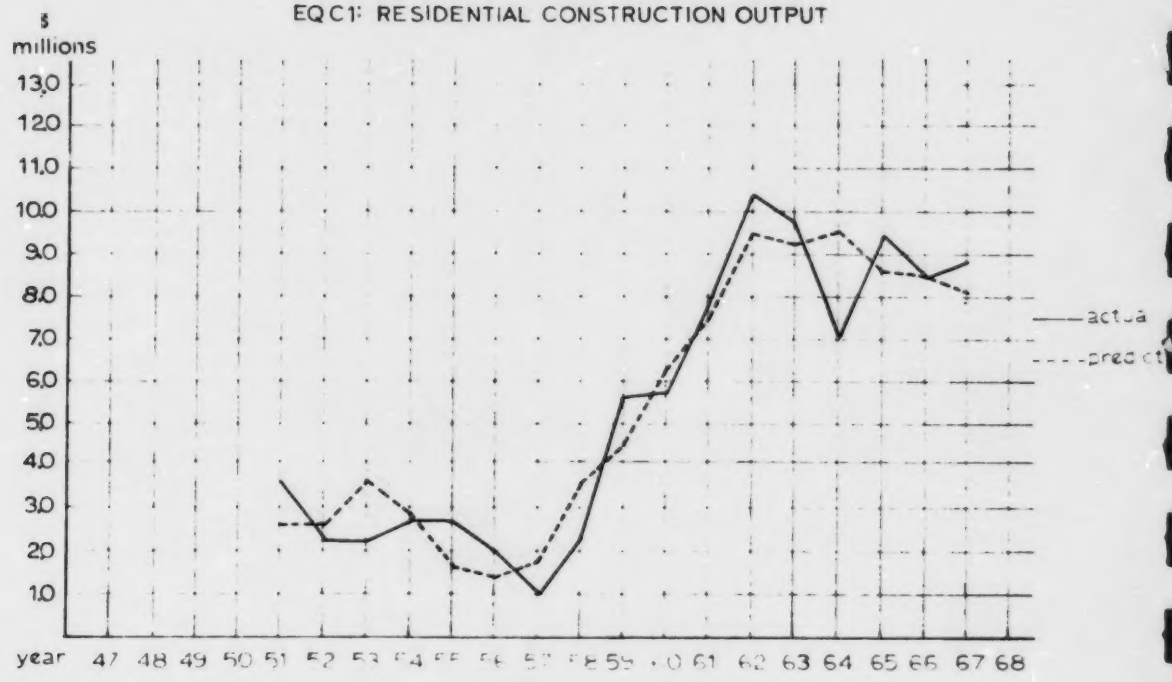


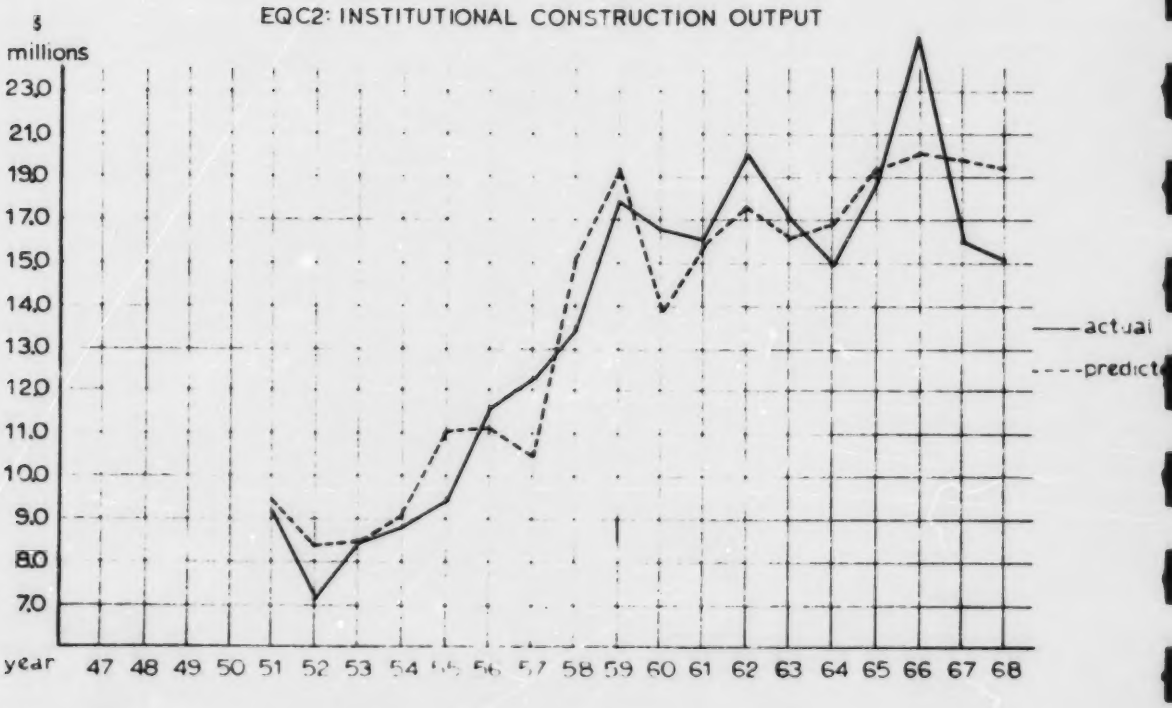
EQPOP1: LABOUR FORCE



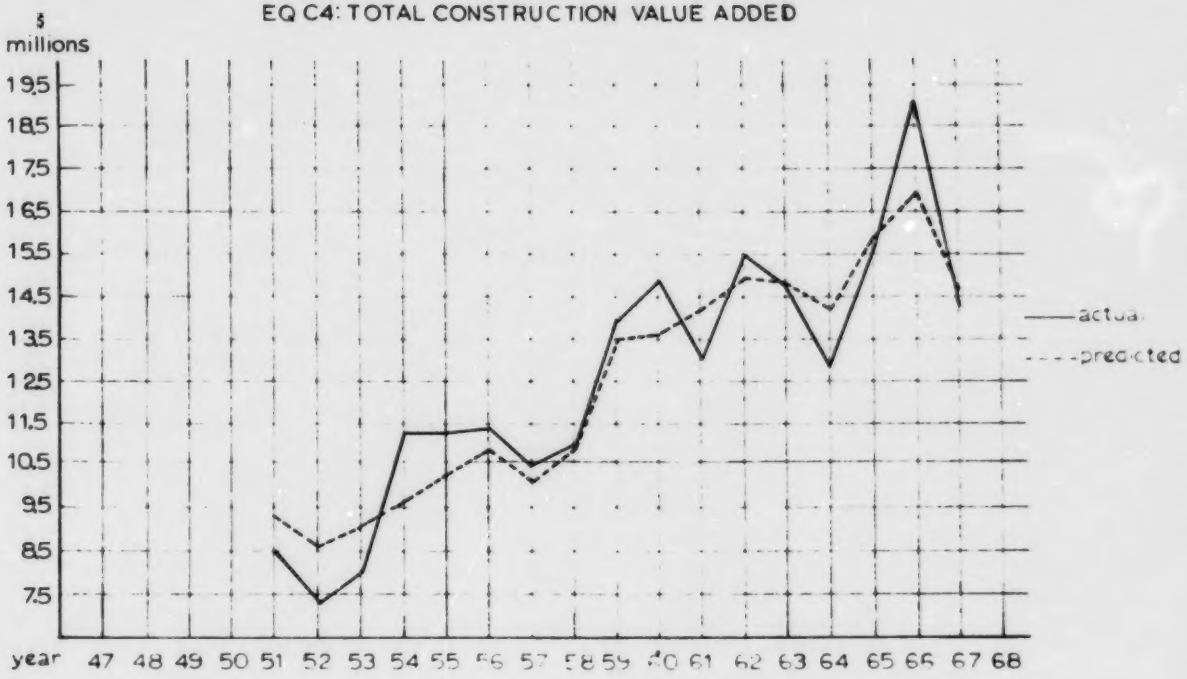
EQOP1: GROSS PROVINCIAL PRODUCT



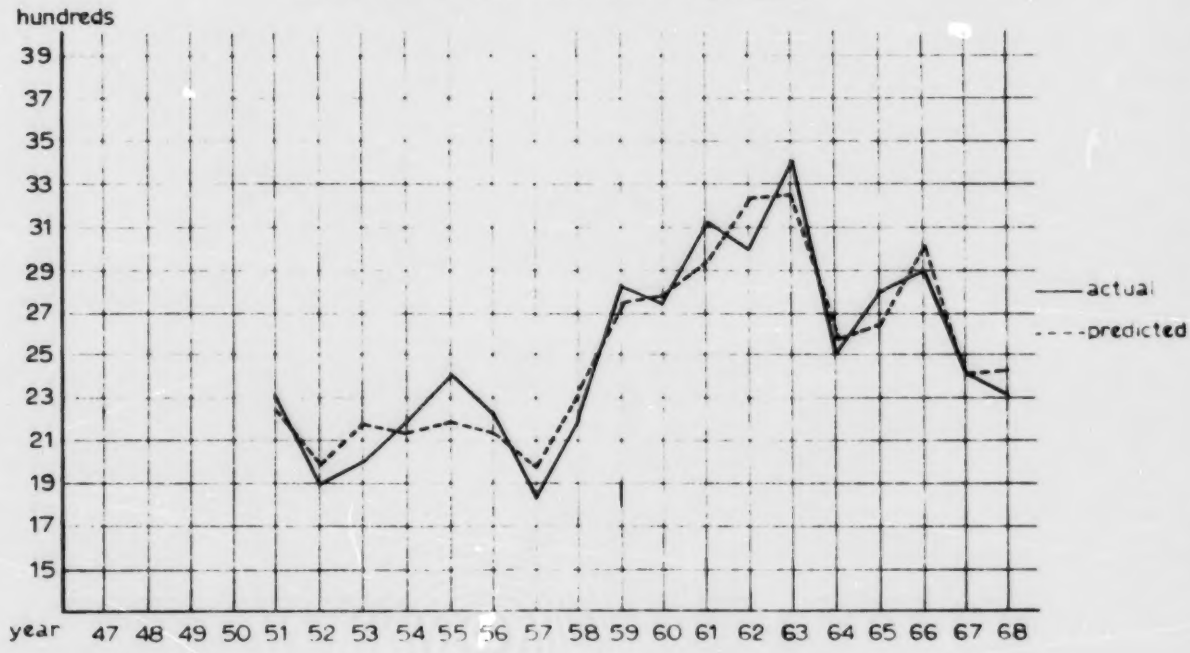

EQC1: RESIDENTIAL CONSTRUCTION OUTPUT
$ millions
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
year
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
actua
predict

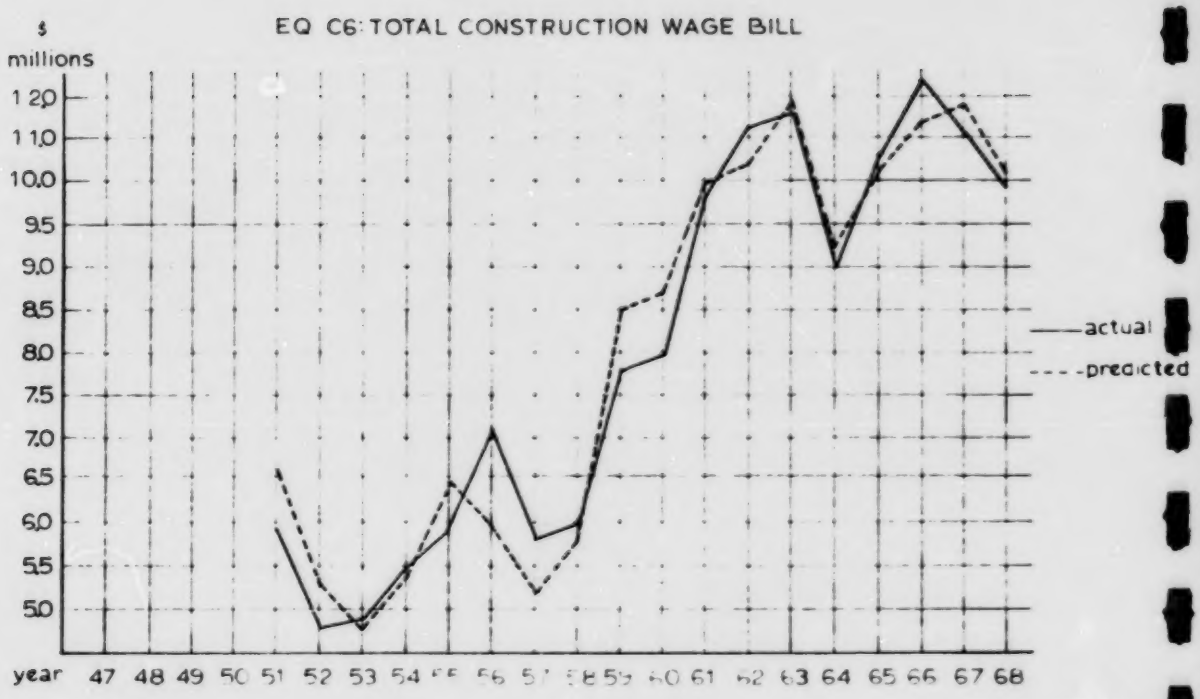

EQC2: INSTITUTIONAL CONSTRUCTION OUTPUT
$ millions
23.0
21.0
19.0
17.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
year
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
actual
predicte

EQ C4: TOTAL CONSTRUCTION VALUE ADDED

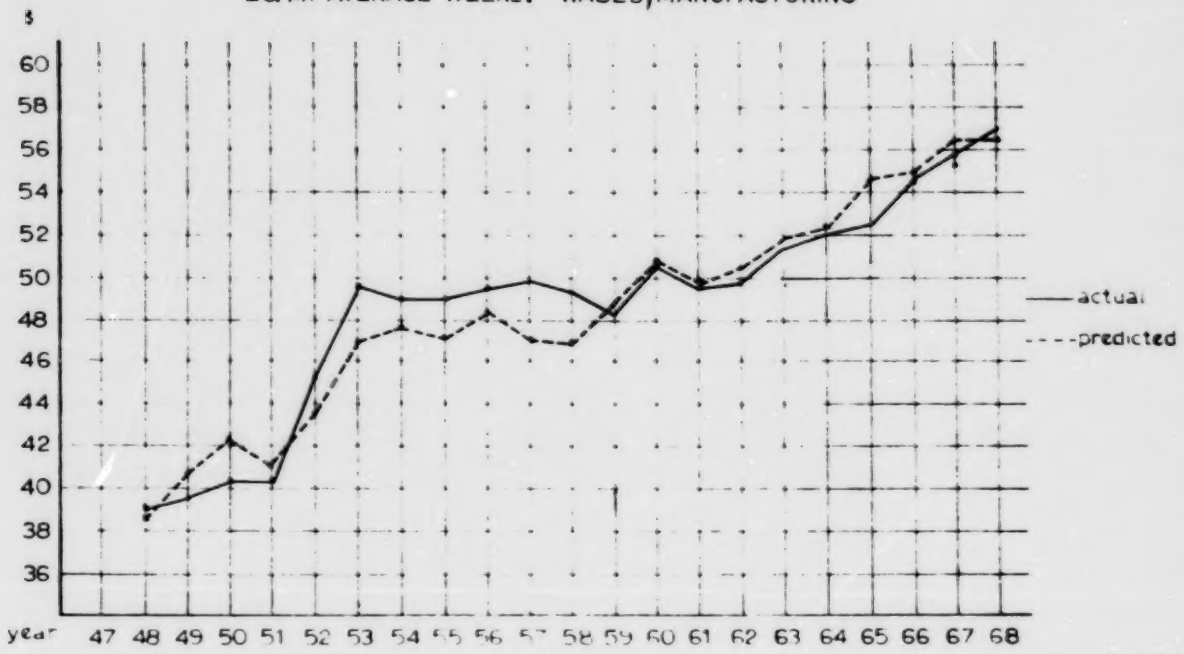


EQ C5: TOTAL CONSTRUCTION EMPLOYMENT

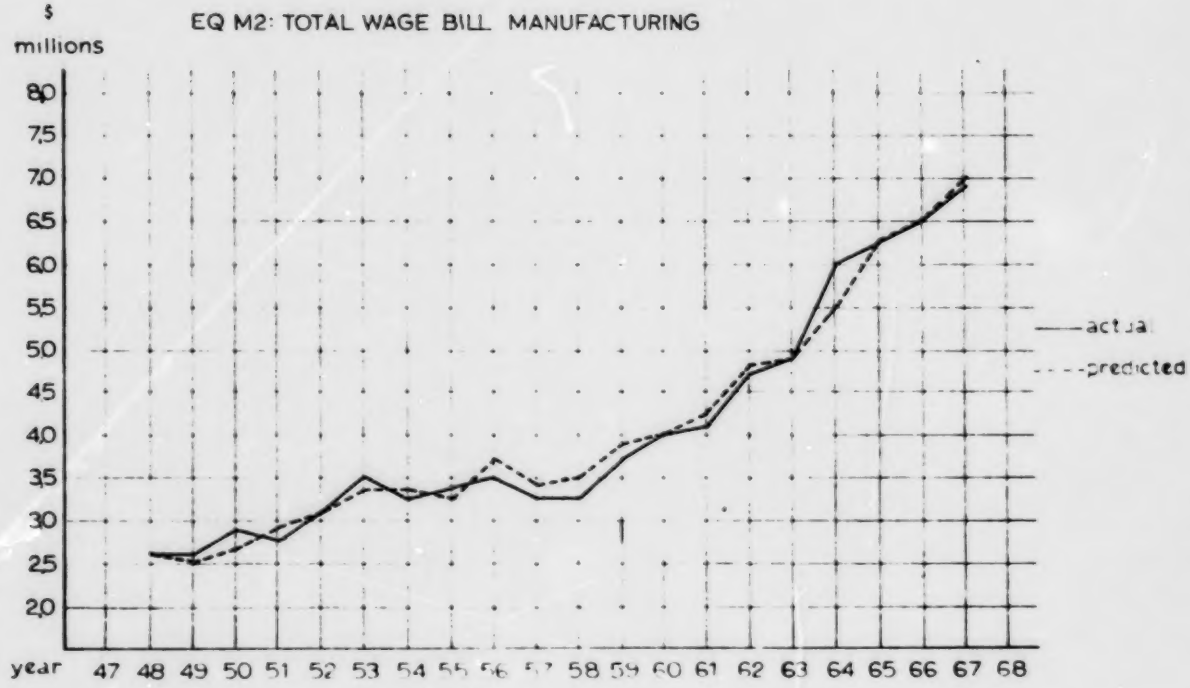



EQ C6: TOTAL CONSTRUCTION WAGE BILL
$ millions
12.0
11.0
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
year
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
actual
predicted

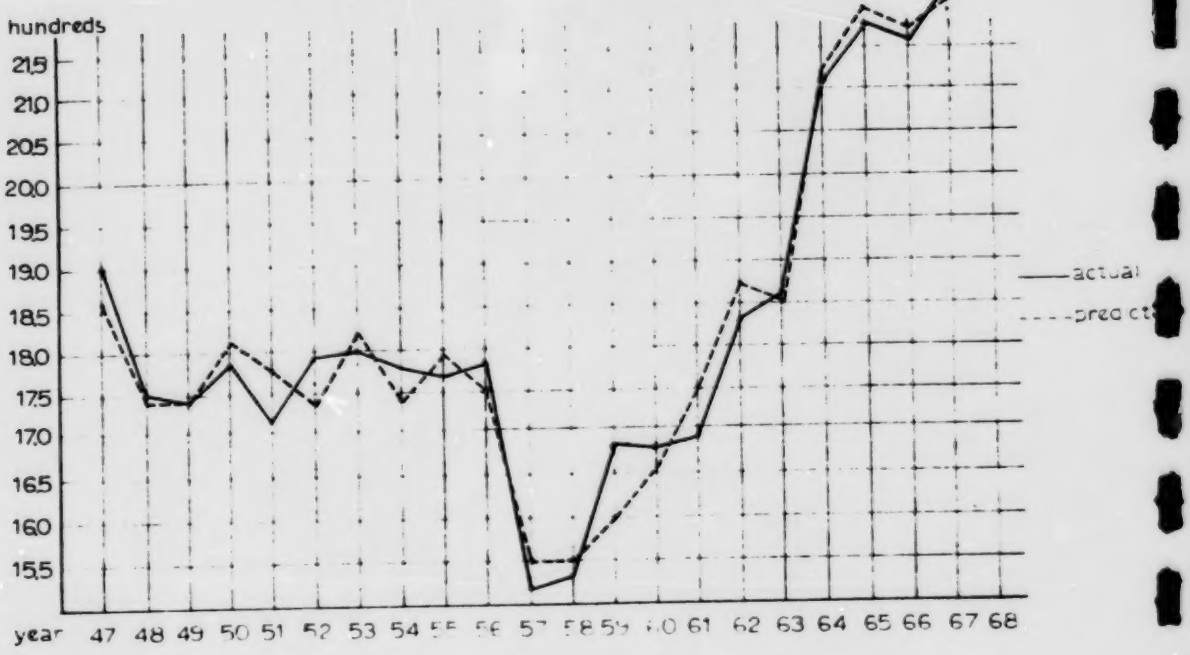
EQ M1 AVERAGE WEEKLY WAGES, MANUFACTURING



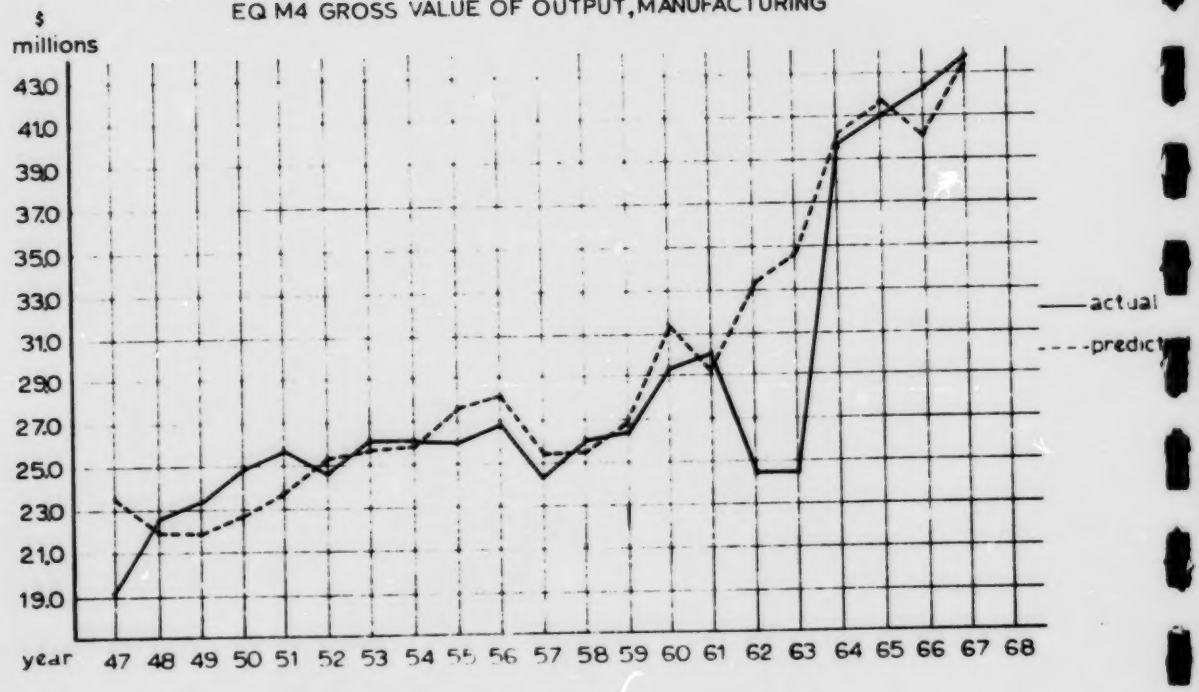
EQ M2: TOTAL WAGE BILL MANUFACTURING

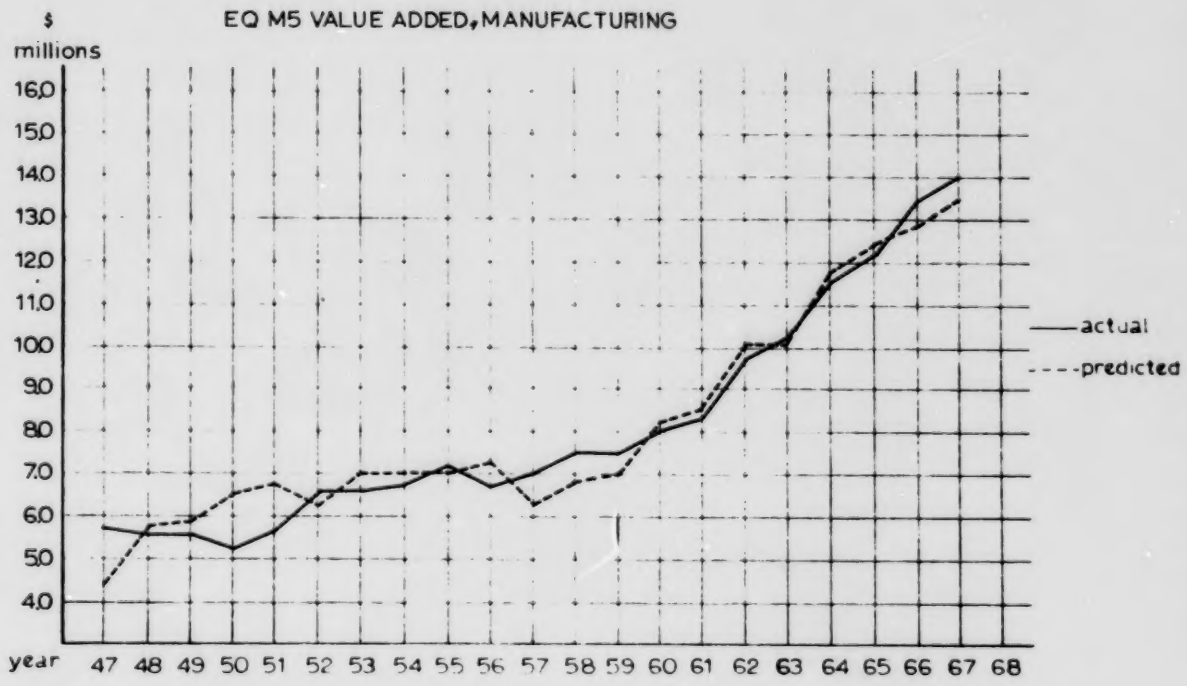


EQ M3 EMPLOYMENT, MANUFACTURING

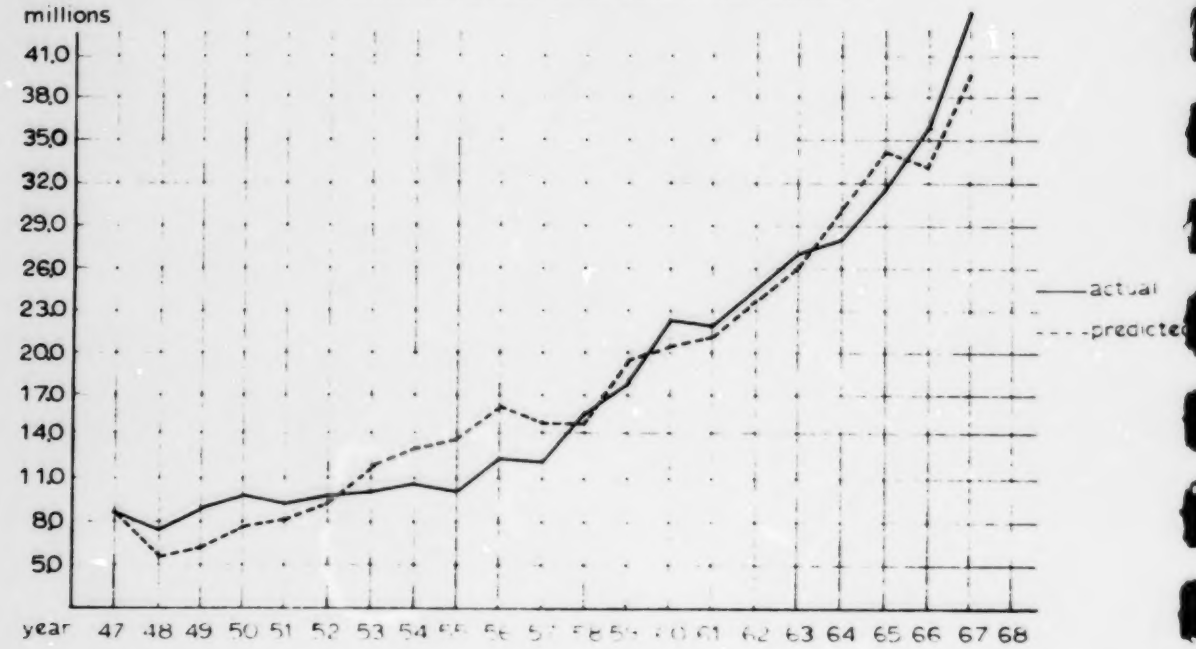


EQ M4 GROSS VALUE OF OUTPUT, MANUFACTURING

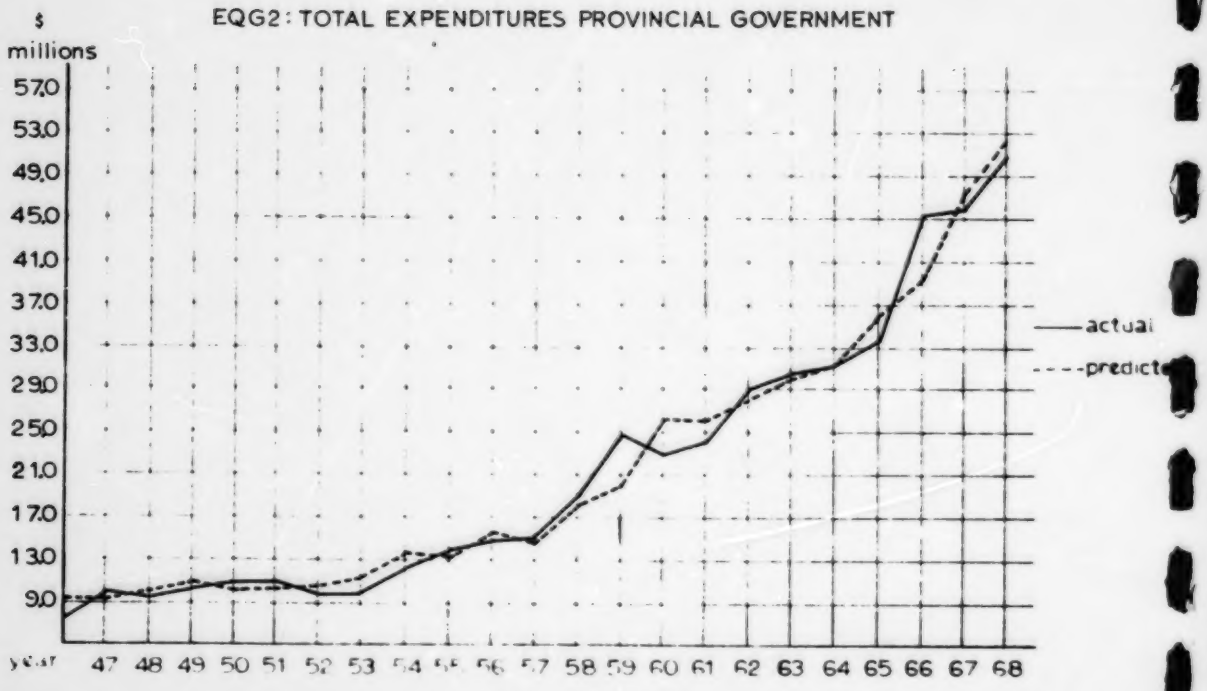



EQ M5 VALUE ADDED, MANUFACTURING
$ millions
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
year
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
actual
predicted

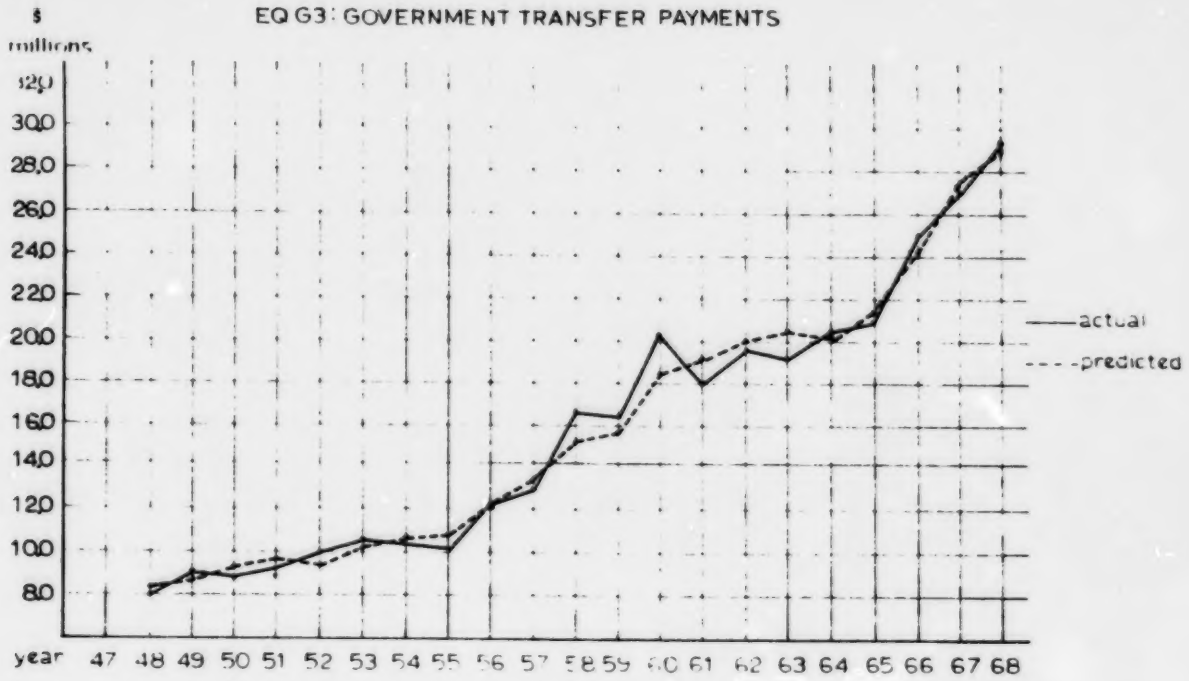
EQ G1: TOTAL REVENUES PROVINCIAL GOVERNMENT



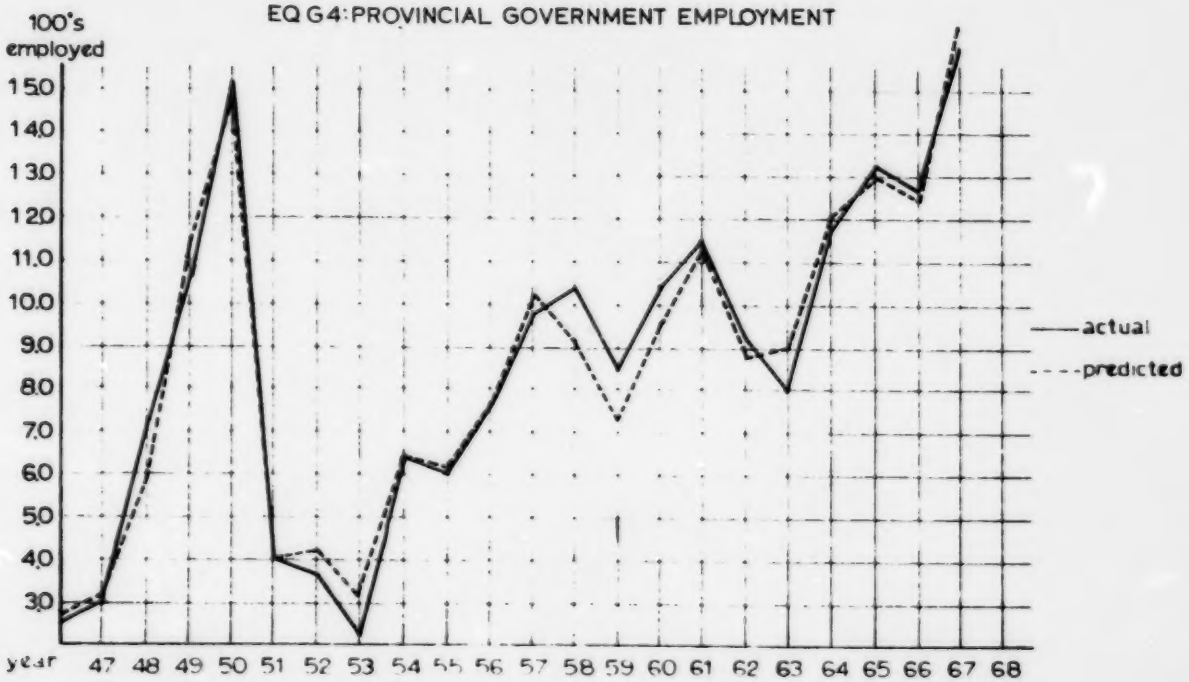
EQG2: TOTAL EXPENDITURES PROVINCIAL GOVERNMENT

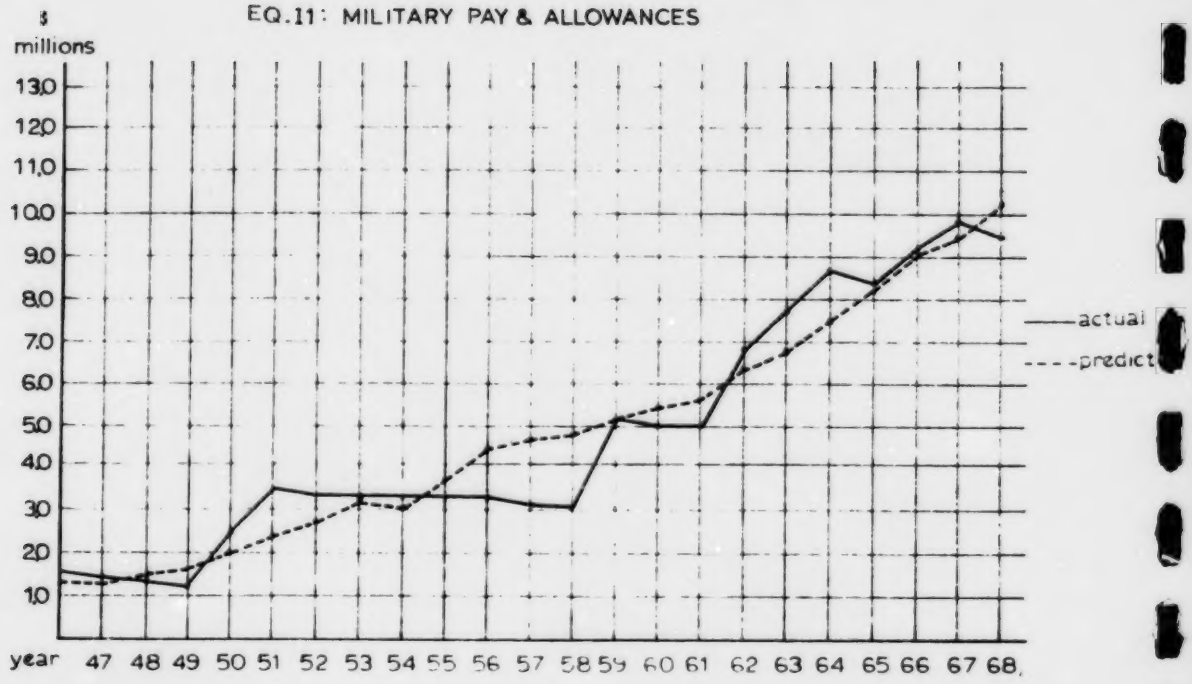


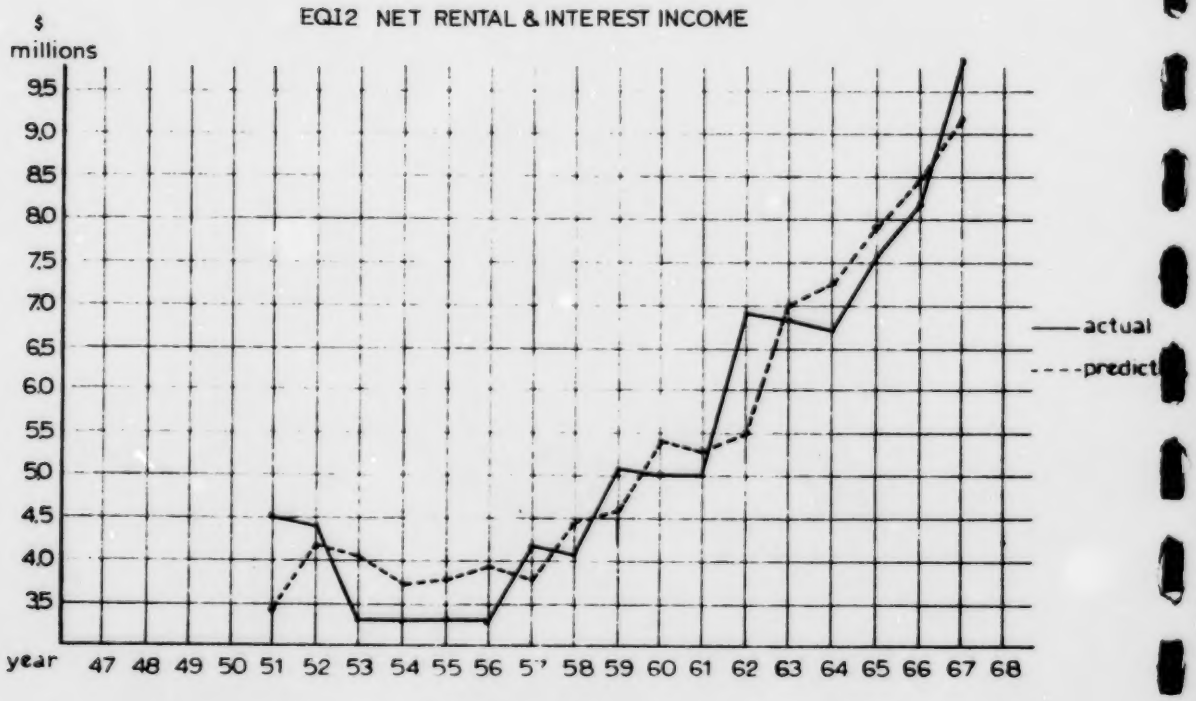
EQ G3: GOVERNMENT TRANSFER PAYMENTS

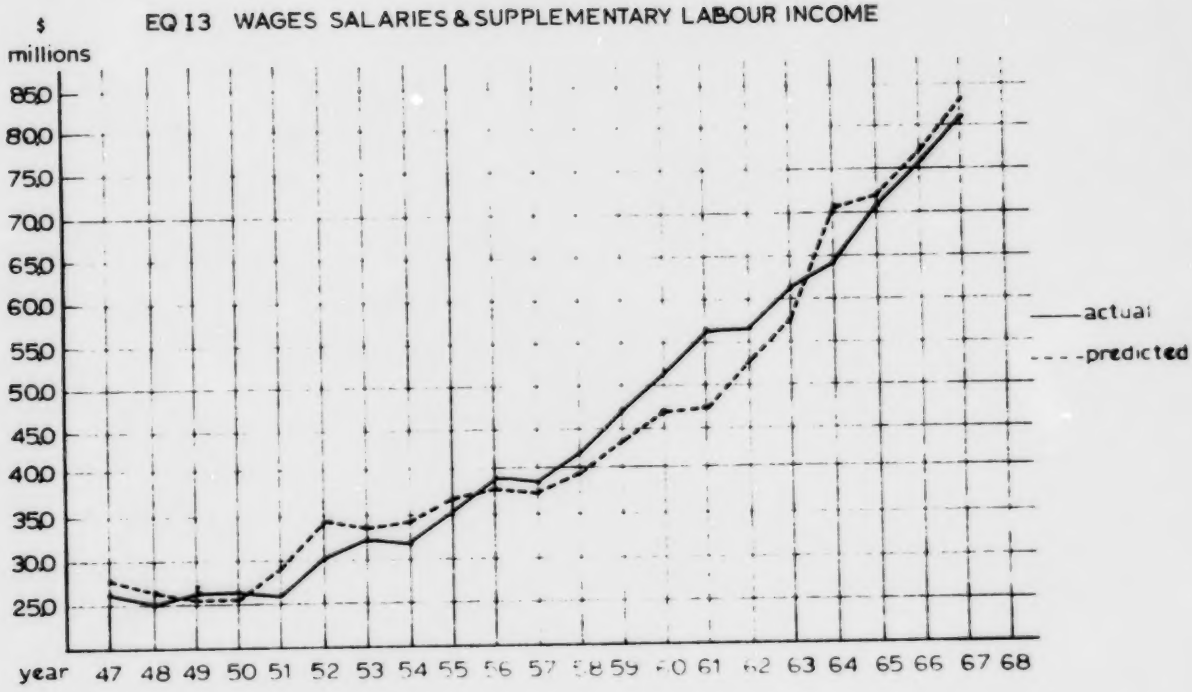


EQ G4: PROVINCIAL GOVERNMENT EMPLOYMENT

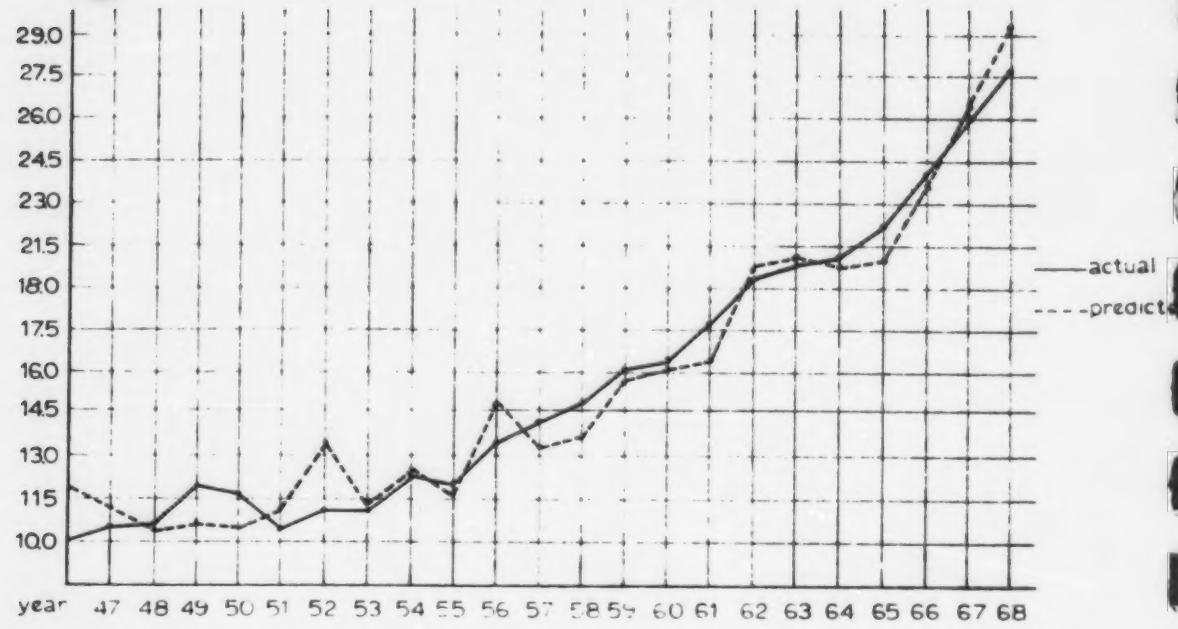



EQ.11: MILITARY PAY & ALLOWANCES
$ millions
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
year 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
actual
predict

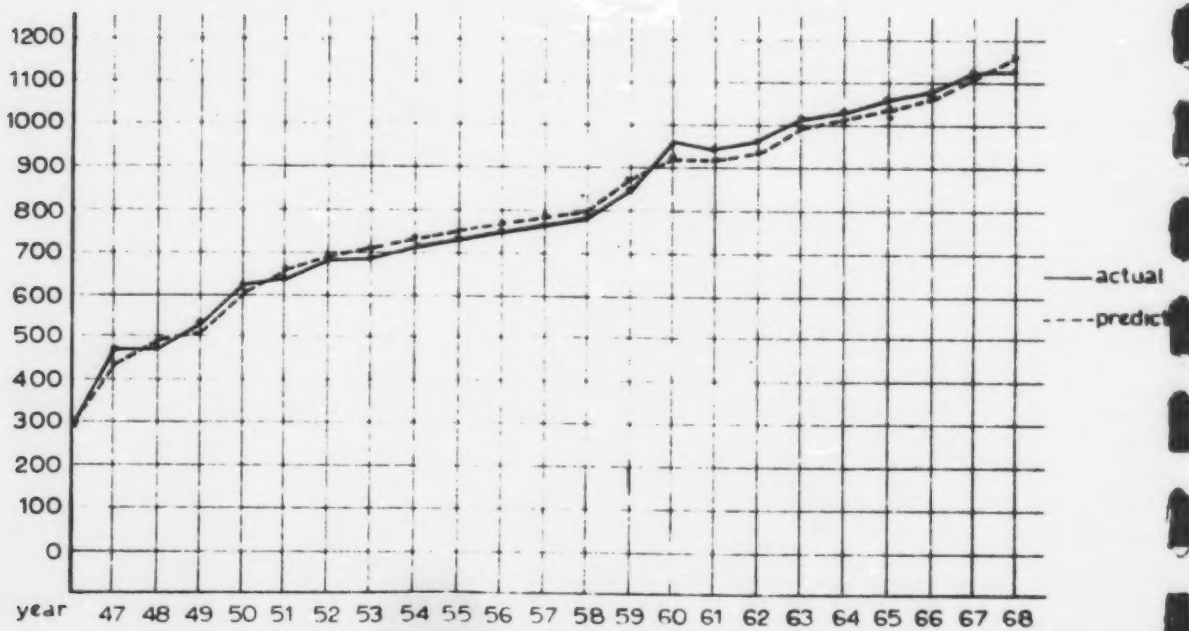

EQ12 NET RENTAL & INTEREST INCOME
$ millions
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
year 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
actual
predict


EQ 13 WAGES SALARIES & SUPPLEMENTARY LABOUR INCOME
$ millions
850
800
750
700
650
600
550
500
450
400
350
300
250
year 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
actual
predicted

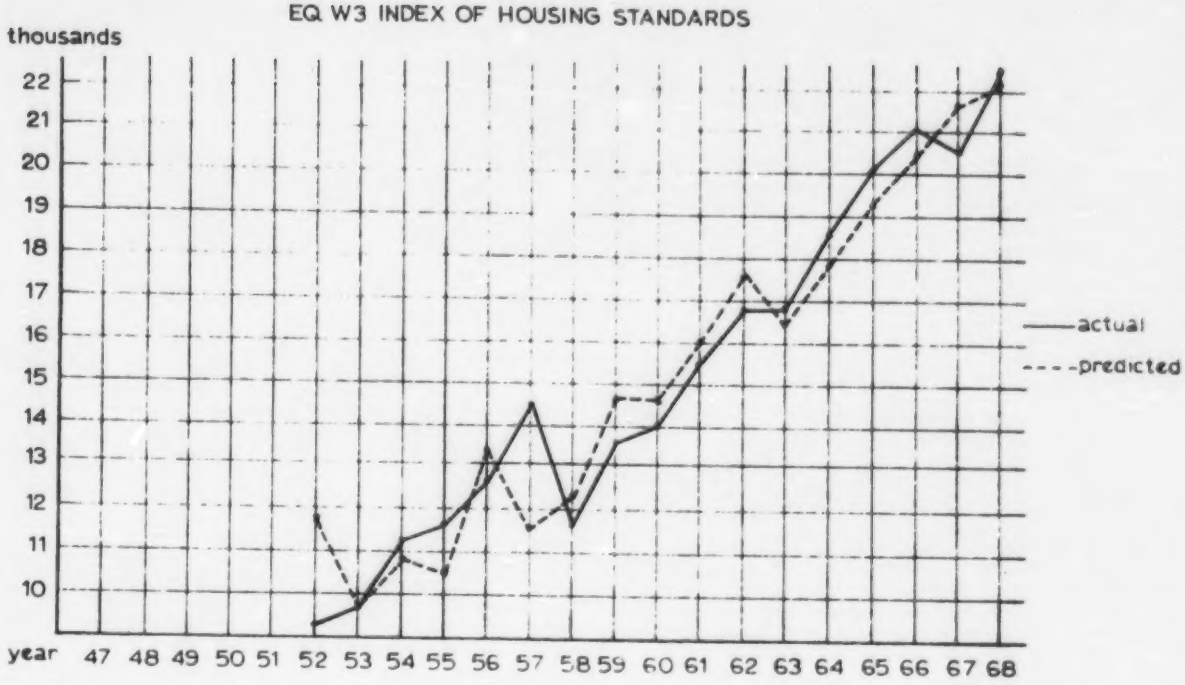
EQ W1 EDUCATION INDEX



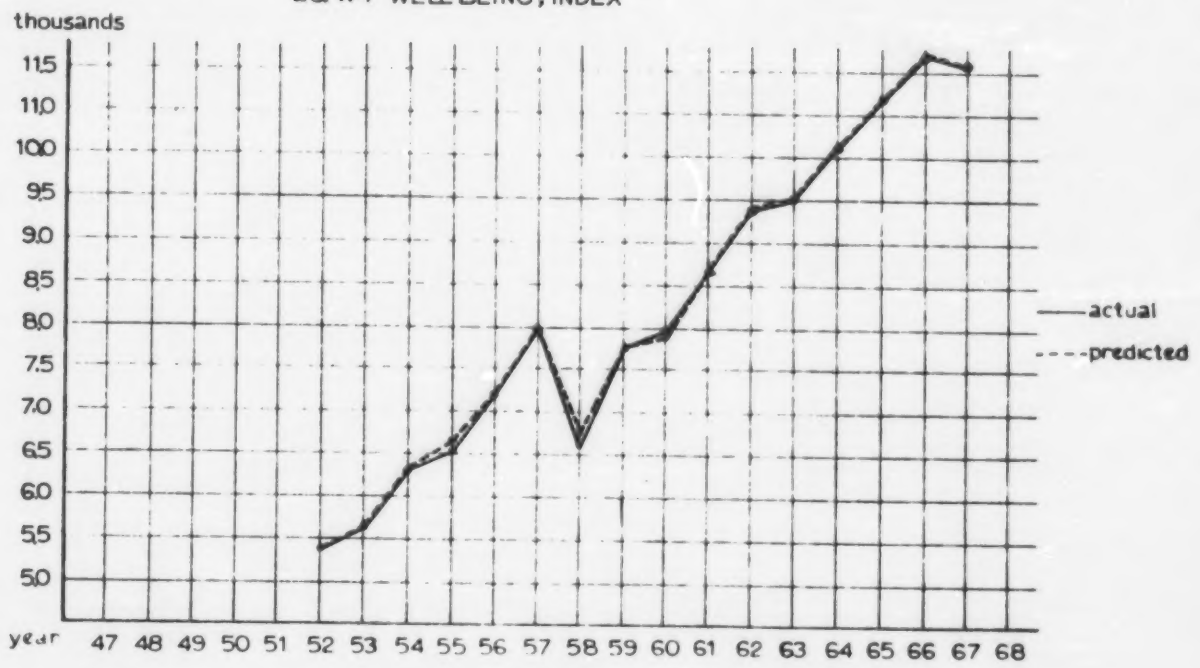
EQ W2 INDEX OF HEALTH SERVICES



EQ W3 INDEX OF HOUSING STANDARDS



EQ W4 WELL BEING, INDEX



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64-201: Construction in Canada
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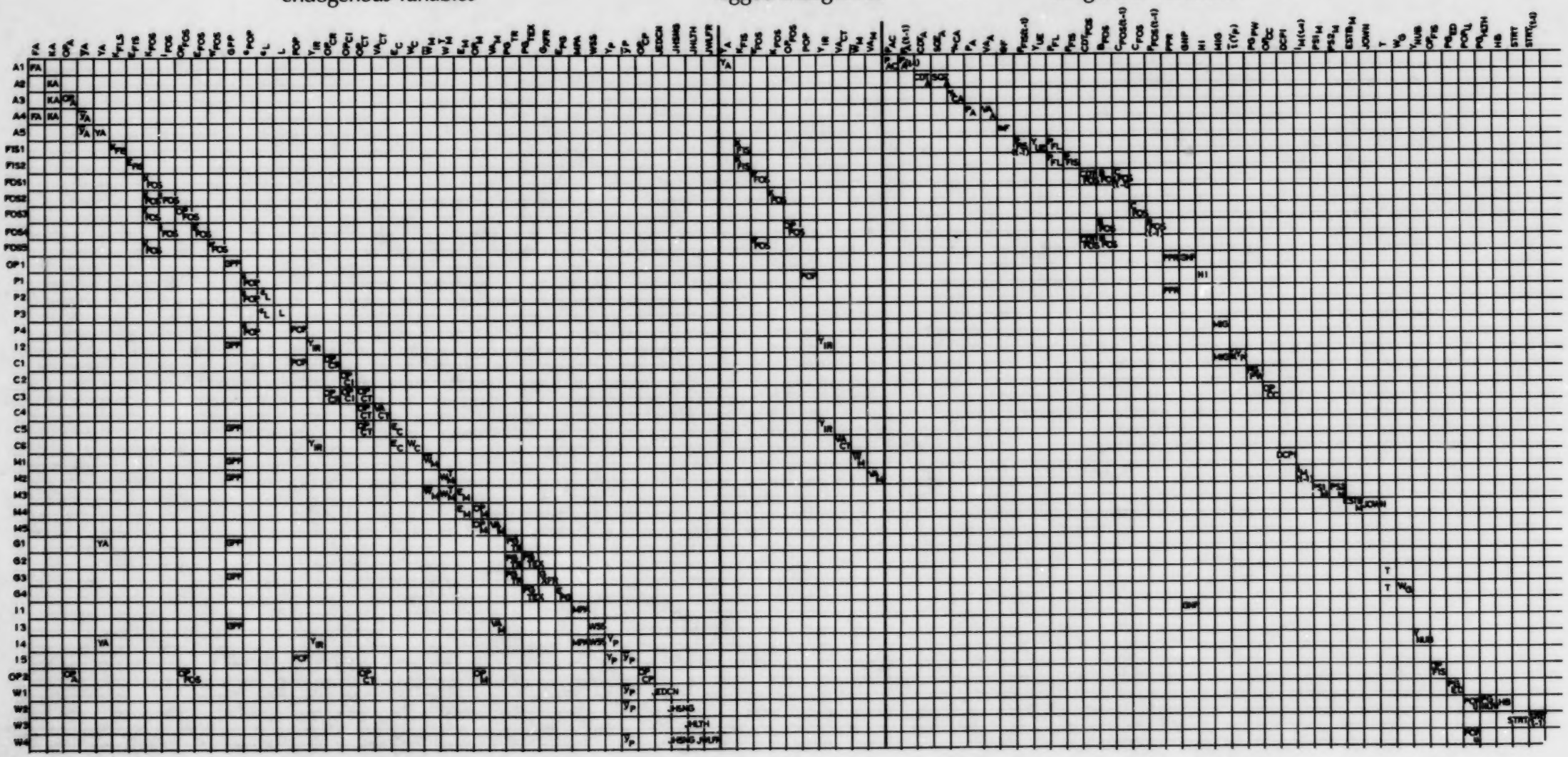
Fig XIV THE MODEL MATRIX REPRESENTATION FORM



ALPHABETICAL LISTING OF VARIABLES

SYMBOL	TITLE	UNITS
B_{FOS}	boats fishing, offshore fishery	(1)
$\%C_A$	proportion of commercial farms, agriculture	(.)
CDT_A+	credit used, agriculture	($1000)
CDT_{FOS}+	credit used, offshore fishery	($1000)
C_{FOS}	boats constructed, offshore fishery	(1)
DCPI	change in PEI consumer price index = $CPI_{(t-1)}/CPI$	(.)
E_C	employment, construction	(1)
E_{FIS}	employment, inshore fishery	(1)
E_{FOS}	employment, offshore fishery	(1)
E_M	employment, manufacturing	(1)
E_{PG}	employment, provincial government	(1)
$ESTB_M$	number of establishments, manufacturing	(1)
F_A	average farm size, agriculture	(1)
#F	number of farms, agriculture	($1000)
GPP*	gross provincial product (PEI)	($1000)
G_{XFR}	government transfers to persons	($1000)
HB+	number of hospital beds	(1)
I_{FOS}	net investment, offshore fishery	($1000)
I_M++	net investment, manufacturing	($1000)
JEDCN*	index of education	(1)
JHLTH*	index of health services	(1)
JHSNG*	index of housing standards	(1)
JOWN	index of ownership, manufacturing	(%)
JWLFR*	index of general well-being	(1)

SYMBOL	TITLE	UNITS
PG_{TEX}	provincial government, total expenditures	($1000)
PG_{TR}**	provincial government, total revenues	($1000)
e_{POP}	expected population	(1000)
POP	actual population	(1000)
POP_u	urban population	(1000)
PPR	population participation rate	(.)
$PS1_M$	plant size indicator 1, manufacturing	(%)
$PS2_M$	plant size indicator 2, manufacturing	(%)
SQZ_A	price/cost squeeze, agriculture	(.)
STRT++	number of housing starts	(1)
T	time	(1946=6; 1968=28)
$\bar{t}(Y_p)$	average personal income tax rate	(.)
VA_A	value added, agriculture	($1000)
VA_{CT}	value added, total construction	($1000)
VA_M	value added, manufacturing	($1000)
W_C	total annual wage bill, construction	($1000)
W_G+	total annual wage bill, government	($1000)
W_M^T	total annual wage bill, manufacturing	($1000)
$\bar{w}_M$	average weekly wages and salaries,manufacturing	($1000)
WSS**	wages, salaries and supplementary labor income	($1000)
$\bar{y}_A$**	net income per farm, agriculture	($1)
Y_A	total net income, agriculture	($1000)
Y_{IR}**	net rental and interest income of persons	($1000)
Y_{NUB}	net income of non-farm unincorporated business	($1000)
$\bar{y}_p$	personal income per person	($1)
Y_{UE}	income from unemployment insurance payments	($1000)

SYMBOL	TITLE	UNITS
K_A	capital stock, agriculture	($1000)
K_{FIS}	capital stock, inshore fishery	($1000)
K_{FOS}	capital stock, offshore fishery	($1000)
L	actual labor force	(1000)
e_L	expected labor force	(1000)
MIG	migrations	(1000)
MPA	military pay and allowances	($1000)
NI	rate of natural increase (births minus deaths)	(.)
OP_A	output, agriculture	($1000)
OP_{CC}	output, commercial construction	($1000)
OP_{CI}	output, institutional construction	($1000)
OP_{CP}**	output, commodity producing sectors	($1000)
OP_{CR}	output, residential construction	($1000)
OP_{CT}	output, total construction	($1000)
OP_{FIS}	output, inshore fishery	($1000)
OP_{FOS}	output, offshore fishery	($1000)
OP_M	output, manufacturing	($1000)
P_A	product price index, agriculture	(1961 = 100)
P_{AC}	cost price index, agriculture	(1961 = 100)
P_{FIS}	fish price index, inshore fishery	(1961 = 100)
P_{FOS}	fish price index, offshore fishery	(1961 = 100)
P_{FL}	fish price index, lobsters	(1961 = 100)
PG_{ED}+	provincial government expenditures on education (ordinary)	($1000)
PG_{HLTH}+	provincial government total expenditures on health (ordinary plux capital = total)	($1000)
PG_{PW}+	provincial government expenditures on public works (total)	($1000)

SYMBOL	TITLE	UNITS
π_{FOS}	profitability, offshore fishery	(%)

"*" signifies a primary target

"**" signifies a secondary target

"+" signifies a primary instrument

"++" signifies a secondary instrument